CONFIRMATION STUDY AND EVALUATION
OF REMEDIAL ALTERNATIVES REPORT

Pesticide Site, Area G
NWIRP - McGregor, Texas

McGREGOR NAVAL WEAPONS
TX9170024708
X-Ref SA Vol 1

For

Baker & Botts
3000 One Shell Plaza
Houston, Texas 77002

W.O. #53-01

July, 1985

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The following members of the staff of ERM-Southwest, Inc. participated in the planning and execution of this project and the preparation of this report.

Participant	Contribution
Harry L. Little, P.E.	Project Manager and Principal Investigator
Dianna Chianis	Remedial Alternatives Analysis
Guy L. Swinford	Ground Water Investigation, and Soils Sampling
Sharon L. Crabb	Soils Sampling and Biological Treatment
Georgia A. Bost	Definition of Remedial Objectives

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SUMMARY

ERM-Southwest, Inc. was retained by the law firm of Baker & Botts to complete this Confirmation Study on the pesticide site at Area G, NWIRP, McGregor, Texas for their client, the CIBA-GEIGY Corporation. The study was conducted in response to a court approved agreement with the U.S. Navy, the land-owner, who is represented by the U.S. Department of Justice.

The purpose of the study was to define the extent of pesticide effects at the site, to evaluate six remedial alternatives based upon the information gathered, and to define the best alternative to meet the remedial objective.

A total of 122 soil sampling locations were established within and around the site. Over 210 soil samples were collected and analyzed for pesticide concentration.

Three pairs of monitoring wells were installed in order to sample the shallow ground water. Analytical results indicated that the shallow ground water has not been affected.

Based on five potential pathways for pollutant migration and the need to minimize human exposure and protect the environment, the remedial objective was defined as the remediation and/or isolation of those soils containing 10 ppm or more of pesticides. A total of 4125 cubic yards of soil was estimated to be in place at the site with those concentrations.

Six alternatives were evaluated based on associated environmental risks and human exposure, technological feasibility, reliability, long term maintenance and monitoring, and estimated cost.

The recommended remedial alternative includes the partial consolidation of 1400 cubic yards of the affected soil into a smaller area of the site, constructing side berms and a low permeability cap. The excavated areas will be backfilled with clean soil, seeded and fertilized to prevent ponding. The estimated capital cost for this alternative is $239,000. Long term (30 years) maintenance and monitoring costs were estimated to equal $157,100.

It was also recommended that:

(1) The two acre area of lesser affected soils east and west of the site be plowed, seeded and fertilized at an estimated capital cost of $2,000,

(2) That a security fence be installed around the low permeability cap area,

(3) That the cap be maintained, and

(4) That monitoring the shallow ground water for pesticides be continued for three years.

CONFIRMATION STUDY AND EVALUATION OF REMEDIAL ALTERNATIVES REPORT

Pesticide Site, Area G
NWIRP - McGregor, Texas

1 - INTRODUCTION

ERM-Southwest, Inc. was retained by the law firm of Baker & Botts to complete a confirmation study on a pesticide site for their client, the CIBA-GEIGY Corporation. The study is being conducted in response to a court approved agreement with the U.S. Navy, the landowner, who is represented by the U.S. Department of Justice.

The purpose of the study is to define the extent of pesticide effects at the site, to evaluate several remedial alternatives based upon the information gathered, and to define the best alternative to meet the remedial objectives.

The study was divided into four tasks. These tasks were:

1. Review of previous data,
2. Define extent of soil contamination,
3. Define possible groundwater contamination, and
4. Remedial alternatives analysis.

The results of the Confirmation Study are presented in this report.

2 - BACKGROUND

Included in this Confirmation Study was a review of previous reports and data provided by the Department of the Navy. The information provided included a 1979 Navy Report entitled "Soil Contamination Investigation," and "Initial Assessment Study" prepared by Envirodyne Engineers in March, 1983 and a "Confirmation Study and Summary of Remedial Action" prepared by the Environmental Branch of the Naval Facilities Engineering Command in August, 1983. Drilling logs and water levels were also provided by Hercules Inc., the Government facilities contractor at the Naval Weapons Industrial Reserve Plant (NWIRP), for monitoring wells installed in nearby Area F.

The pesticide contamination site at Area G was first documented by the Navy in 1979. A general site location is shown in Figure 2-1. The "Soil Contamination Investigation" report discussed the history and past operations of the site. The investigation included surface and shallow soil sampling and analysis both in the obviously affected areas and in nearby areas which could have been affected by the pesticides. The results indicated that the pesticides were located principally in the areas where vegetation was sparse. The primary pesticide found was DDT.

At the time of the 1979 study, it was felt that significant concentrations were only six to eight inches in depth. However, two deeper soil samples were also collected. One of the deeper samples indicated that pesticide concentrations were slightly higher at the 42 inch depth than at 24 inches.

The Envirodyne "Initial Assessment Study" was primarily an analysis of the data collected in 1979, and included a consideration of local factors (geology, groundwater, land use and surface water) which could affect the site. Recommendations were made for additional monitoring at the site.

The Navy "Confirmation Study and Summary of Remedial Action" performed an analysis of a series of aerial photographs of the site from 1952 to 1982. Soil sampling in the areas devoid of vegetation was conducted in 1982 and 1983. This study confirmed that the bare areas were the locations of high pesticide concentrations. That report stated that the higher concentrations were limited to the upper 12 inches of soil. Recommendations were made for remedial action activities at the site.

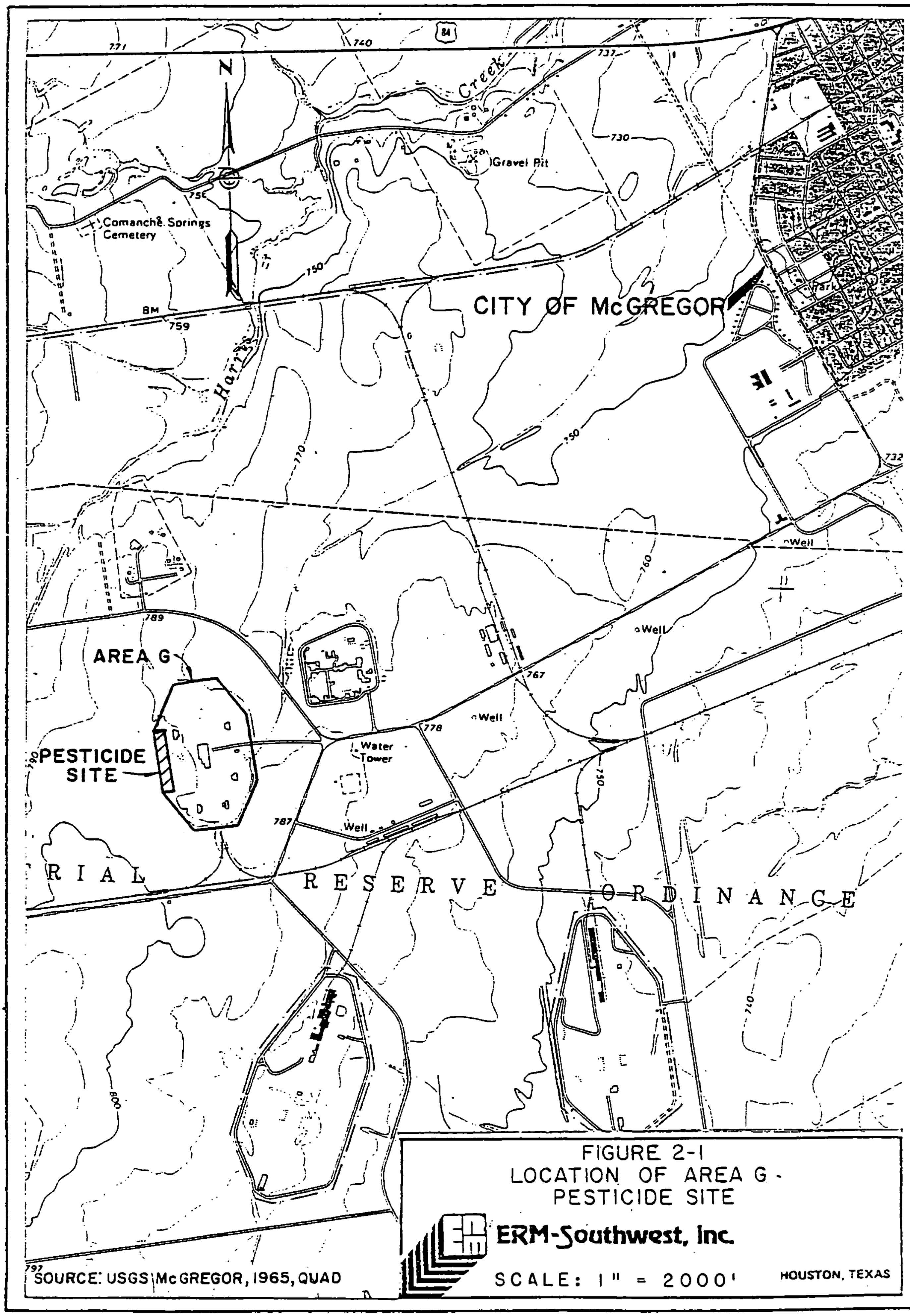


FIGURE 2-1
LOCATION OF AREA G -
PESTICIDE SITE

ERM-Southwest, Inc.

SCALE: 1" = 2000'

HOUSTON, TEXAS

In December, 1983 the U.S. Department of Justice on behalf of the Navy instituted a civil action against the CIBA-GEIGY Corporation regarding the pesticide site at Area G. An agreement was entered into in July, 1984 whereby an initial removal of concentrated pesticide materials and a more in depth confirmation study of soil pesticide effects would be completed.

An initial removal action was performed in July, 1984. A total of seven truck loads of material were excavated, hauled to and disposed of in a licensed commercial hazardous waste landfill in Emelle, Alabama. During this operation several areas of obvious surface contamination, based on visual observation of concentrated pesticide material and bare spots, were removed. During the excavation operation, several streaks of brightly colored pesticide material were discovered below the soil surface.

Subsequent sampling indicated that the volume of affected soil was much more extensive than previously reported.

In February, 1985 a "Confirmation Study Final Work Plan for Area G" was agreed upon by the interested parties. This report presents the results of the Confirmation Study for the Area G pesticide site.

3 - SITE INVESTIGATION

3.1 Purpose

After review of previous data and the initial removal of affected material in July 1984, an expanded sampling program was developed. The intent of this program was to delineate the areal extent of affected soil. An additional activity was monitoring well installation to determine if pesticides were present in the shallow ground water.

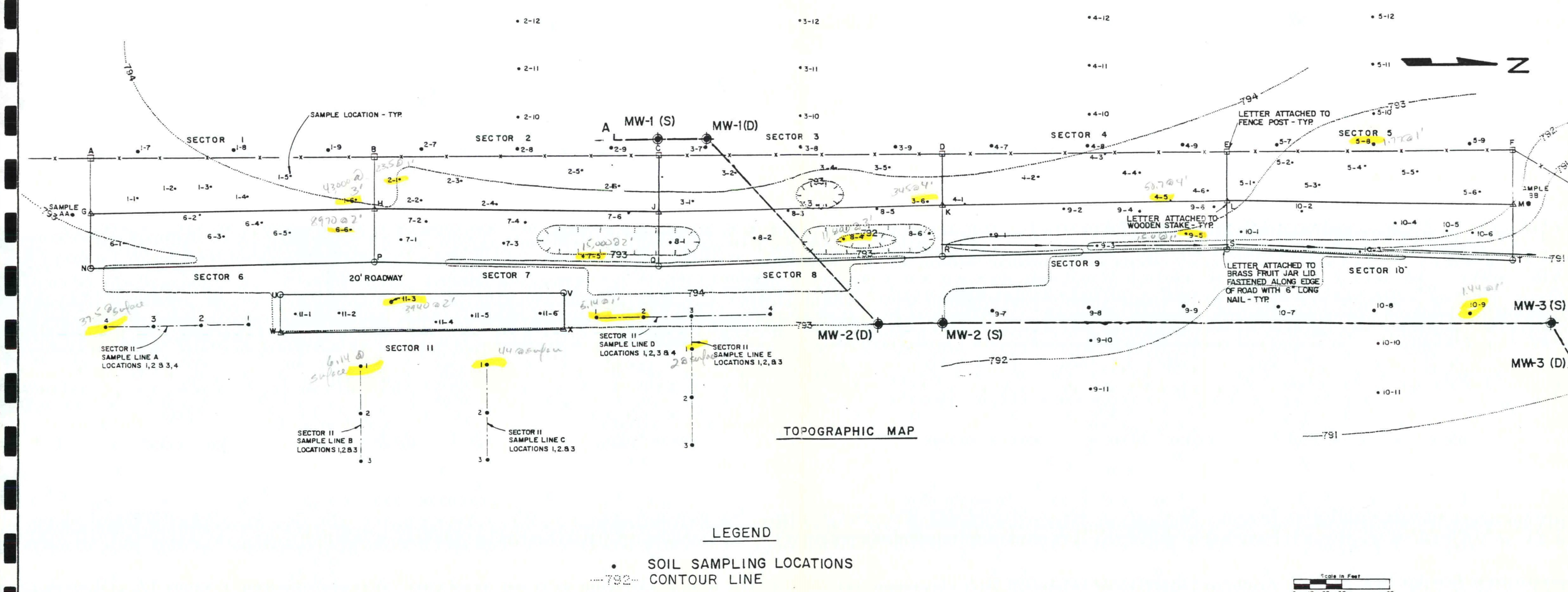
The sampling methods and analytical results for these activities are discussed in the following sections.

3.2 Soils Investigation

3.2.1 Methods

Following the initial removal action, the first soil samples were collected during the week of July 23, 1984. The Area G site was divided into eleven sectors, using a semi-permanent marking system. Each sector measured approximately 180 feet by 35 feet, except Sector 11 , which was 180 feet by 24 feet, as illustrated in Figure 3-1. In each sector, six randomly located sampling points were staked out by Mr. Allen L. Chestnut, U.S. Navy On-site Representative. At that time, only Sectors 1 through 6 were sampled. Grab samples were collected at the surface, and at 6 and 12 inch depths. Each surface grab sample was collected with a new stainless steel spoon and stored in a new glass jar. For the deeper samples, the holes were advanced with a post hole digger. Each hole was thoroughly cleaned of any loose soil at each sample depth and the sample was collected with a new stainless steel spoon. Between each sample the post hole digger was washed with water. At each of the three depths, portions of the samples were used to make composite samples for each horizontal increment.

Additional soil samples were collected during the week of August 13, 1984. In each sector, samples were collected at four of the six sampling locations. In the even numbered sectors, locations 2, 4, 5, and 6 were sampled. In the odd numbered sectors locations 2, 3, 5, and 6 were sampled. These locations were randomly selected. Continuous two foot long thin-walled (Shelby) tube samples were collected using a truck mounted drill rig. Samples were collected at each foot until a caliche layer was encountered and the Shelby tube could not be advanced. Sampling was terminated at the upper



AREA G PESTICIDE SITE - NWIRP
McGREGOR, TEXAS

ERM-Southwest, Inc.

HOUSTON, TEXAS

Date	
Scale	1" = 60'
Drawn	DP
Checked	HL
Dwg. No.	
File No.	53-01

FIGURE 3-1

surface of the hard zone. As the soil cores were extracted from the Shelby tubes, the desired depth of sample to be retained was determined on each core. A six-inch sample length was collected three inches above and three inches below the designated sampling point. Each six-inch core was wrapped in aluminum foil and placed in a labelled, zip-lock bag. The soil samples were prepared for compositing by removing the ends and at least 1/4-inch of the outer surface of each core with a new stainless steel knife. Samples were then composited by combining portions of the shaved soil cores in new glass jars.

During February, 1985 the Confirmation Study Final Work Plan for Area G was developed and agreed upon by the interested parties. The remaining portions of the Soils Investigation were then completed in order to fulfill the requirements of the Work Plan.

During the week of February 25, 1985, additional soil samples were collected to further delineate the areal extent of the affected soil. Surface grab samples were collected west of the fence (adjacent to Sectors 1 through 5), east of Sectors 9 and 10, around the perimeter of Sector 11 and north and south of the previously delineated area.

Along the west side of the fence, three samples were collected adjacent to each sector (Sampling points 7, 8, and 9), as shown in Figure 3-1. Each of the three sets of surface grabs were composited for each sector and designated as Surface Composite A. Samples were also collected to the north (Sample BB) and south (Sample AA) of the site.

Additionally, four sampling lines were established to the north, east, and south of Sector 11. Samples collected north of Sector 11 were also used to evaluate the east side of Sector 8. Three or four sampling points were located on each line. At each individual sampling point around Sector 11, discrete samples were collected with spoons and the deeper sample holes were advanced with a soil auger which was washed with water between each sample collection.

Also during the February 25 sampling event, three background surface samples were collected in the field west of the fence at locations shown in Figure 3-2. Surface grabs were collected in the manner previously described to ensure that sample cross-contamination did not occur.

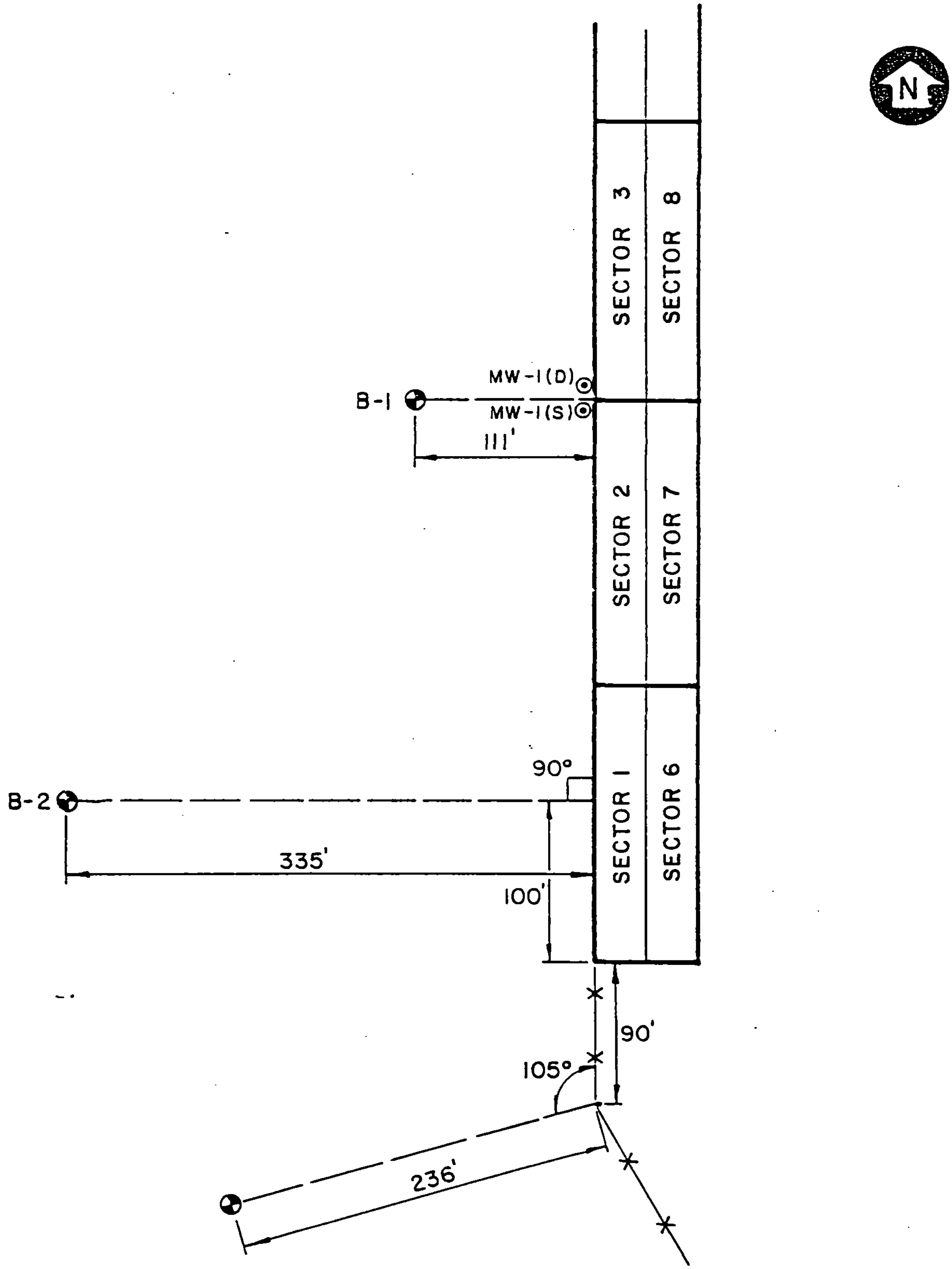


FIGURE 3-2
BACKGROUND SOIL SAMPLING LOCATIONS
SCALE: 1" = 100'

ERM-Southwest, inc.
Houston, Texas

Further sampling was conducted the weeks of March 26 and April 18, 1985 to extend the area of surface sampling outward and to extend some sampling points downward to fully define the extent of affected soil. Sampling procedures for these two sampling events are the same as previously described for the February 25, 1985 sampling event.

Strict chain-of-custody was maintained for the samples throughout the entire soil sampling program. Only new glass jars were used to collect the samples. The sampling equipment was either new stainless steel spoons or carefully washed tube or auger samplers. Soil samples were extracted and analyzed by Craven Laboratories in Austin, Texas for total constituent pesticides.

3.2.2 Results

Laboratory data from the soil sampling program have been tabulated and are presented in Tables 3-1 through 3-12. Data from the eleven individual sectors are presented in Tables 3-1 through 3-11, respectively. Table 3-12 contains miscellaneous data. These results indicate that the primary pesticides which were detected were DDT, toxaphene and benzene hexachloride (BHC) mix. Two other pesticides, aldrin and dieldrin, were detected in a few samples in relatively low concentrations. Endrin and heptachlor were not detected in any of the samples.

The three background samples (Table 3-12) had detectable levels of DDT and toxaphene at the surface, but not at a depth of 1 foot. The average of the background values for DDT was 0.07 ppm and the average of the toxaphene values was 0.19 ppm. No other pesticides were detected in the background samples.

In Sector 1 (Table 3-1), significant levels of DDT were detected to a depth of 3 feet at sample point 1-6. Sample locations 1-2 and 1-5 however were relatively clean below the 1 foot depth. Toxaphene was detected only in the surface and 1 foot composites. In the composite of surface samples collected west of the fence, only DDT was detected and it was less than 1 ppm.

DDT was also the primary pesticide found in samples in Sector 2 down to a depth of 1 foot. The highest values were found at locations 2-4 and 2-6. Toxaphene and low levels of BHC were also found at sample point 2-6. Dieldrin was found in the

TABLE 3-1

SECTOR 1

Sample Identification	ppm			
	BHC	DDT	Toxaphene	Other
Surface Composite	<100	17,000	6,900	
Surface Composite A (West of fence)	<0.01	<0.29	<0.01	
6 inch Composite	<10	1,700	<25	
1 foot Composite	<10	490	150	
1 foot Grabs				
Point 1-2	<0.01	<0.01	<0.01	
Point 1-5	<0.01	0.07	<0.01	
3 foot Composite	<25	953	<50	
3 foot Grabs				
Point 1-2	<0.01	0.06	<0.01	
Point 1-4	<0.01	<0.01	<0.01	
Point 1-5	<0.01	<0.01	<0.01	
Point 1-6	<100	42,000	<250	
Point 1-6 Rerun	<100	43,000	<250	
4 foot Composite	<0.01	0.06	<0.01	

Unless otherwise noted, aldrin, endrin, dieldrin and heptachlor were not detected in any of the samples.

Analyses conducted by Craven Laboratories, Austin, Texas.

TABLE 3-2

SECTOR 2

Sample Identification	ppm			
	BHC	DDT	Toxaphene	Other
Surface Composite	<10	490	510	120 (Dieldrin)
Surface Composite A (West of fence)	<0.01	1.15	1.30	
Surface Grabs				
Point 2-1	<5	135	<10	
Point 2-2	<5	339	<20	
Point 2-3	<0.5	32.6	<2	
Point 2-4	<5	469	<20	
Point 2-5	<5	174	<10	
Point 2-6	18.7	2,800	6,000	
Point 2-10	<0.01	0.22	0.23	
Point 2-11	<0.01	0.11	0.18	
Point 2-12	<0.01	0.12	0.16	
6 inch Composite	<10	300	<25	
6 inch Grabs				
Point 2-1	<0.1	1.93	<0.5	
Point 2-2	<0.5	45.7	<2	
Point 2-3	<0.1	1.01	<0.5	
Point 2-4	22.7	672	42.7	
Point 2.5	<0.5	24.5	<2	
Point 2-6	<10	547	509	
1 foot Composite	2.5	52	76	
1 foot Grabs				
Point 2-1	<0.01	23.5	<0.01	
Point 2-2	<0.01	0.14	0.04	
Point 2-3	0.10	8.61	<0.01	
Point 2-4	<0.01	0.29	<0.01	
Point 2-5	<0.01	<0.01	<0.01	
Point 2-6	<0.01	0.02	<0.01	
Point 2-8	<0.01	<0.01	<0.01	
2 foot Composite	0.01	0.04	<0.01	

TABLE 3-2 (Continued)

SECTOR 2 (Cont.)

Sample Identification	ppm BHC	DDT	Toxaphene	Other
3 foot Composite	0.06	0.03	<0.01	
4 foot Composite	<0.01	0.70	<0.01	

Unless otherwise noted, aldrin, endrin, dieldrin and heptachlor were not detected in any of the samples.

Analyses conducted by Craven Laboratories, Austin, Texas.

TABLE 3-3

SECTOR 3

Sample Identification	ppm BHC	DDT	Toxaphene	Other
Surface Composite	460	730	<100	800 (Dieldrin)
Surface Composite A (West of fence)	0.10	4.08	5.09	
Surface Grabs				
Point 3-1	179	1,200	<20	
Point 3-2	<5	128	361	
Point 3-3	16,000	2,100	4,400	
Point 3-4	6,100	7,200	<200	
Point 3-5	<0.5	11.3	15.1	
Point 3-6	617	958	<20	
Point 3-10	<0.01	0.36	0.43	
Point 3-11	<0.01	0.20	0.31	
Point 3-12	<0.01	0.12	0.17	
6 inch Composite	740	440	100	
6 inch Grabs				
Point 3-1	34.1	275	<10	
Point 3-2	<5	111	323	
Point 3-3	8,095	340	516	
Point 3-4	363	371	<20	
Point 3-5	0.14	2.62	<0.5	
Point 3-6	23.3	724	<20	
1 foot Composite	110	160	<25	
1 foot Grabs				
Point 3-2	<0.01	0.59	0.19	
Point 3-5	2.65	1.90	<0.10	
Point 3-8	<0.01	0.06	0.06	
3 foot Composite	13,200	853	<250	
3 foot Composite Rerun	34,000	2,050	<250	

TABLE 3-3 (Continued)

SECTOR 3 (Cont.)

Sample Identification	ppm BHC	ppm DDT	ppm Toxaphene	ppm Other
3 foot Grabs				
Point 3-2	<0.01	0.03	<0.01	
Point 3-2 Rerun	<0.01	0.06	<0.01	
Point 3-3	82.6	3.26	<5.0	
Point 3-3 Rerun	60.2	6.92	<0.10	
Point 3-5	<0.01	<0.01	<0.01	
Point 3-5 Rerun	<0.01	<0.01	<0.01	
Point 3-5 2nd Rerun	0.06	<0.01	<0.01	
Point 3-6	0.08	<0.01	<0.01	
Point 3-6 Rerun	0.15	0.03	<0.01	
Point 3-6 2nd Rerun	<0.01	0.02	<0.01	
3.5 foot Grab				
Point 3-3	0.14	0.24	<0.01	
4 foot Composite	278	1,450	<100	
4 foot Composite Rerun	295	1,550	<100	
4 foot Grabs				
Point 3-2	<0.01	<0.01	<0.01	
Point 3-5	0.70	3.50	<0.10	
Point 3-5 Rerun	0.53	2.90	<0.10	
Point 3-6	4.67	219	<2.5	
Point 3-6 Rerun	7.84	345	<2.5	
4.5 foot Grabs				
Point 3-2	<0.01	<0.01	<0.01	
Point 3-6	0.19	0.70	<0.01	
4.8 foot Grab				
Point 3-5	0.13	2.14	<0.01	

Unless otherwise noted, aldrin, endrin, dieldrin and heptachlor were not detected in any of the samples.

Analyses conducted by Craven Laboratories, Austin, Texas.

TABLE 3-4

SECTOR 4

Sample Identification	ppm BHC	DDT	Toxaphene	Other
Surface Composite	5,300	28,000	50,000	3,400 (Dieldrin
Surface Composite A (West of fence)	0.11	3.95	2.98	
Surface Grabs				
Point 4-10	0.02	0.44	0.56	
Point 4-11	<0.01	0.09	0.10	
Point 4-12	<0.01	0.09	0.12	
6 inch Composite	62	1,500	2,500	210 (Dieldrin)
1 foot Composite	150	280	390	
1 foot Grabs				
Point 4-8	<0.01	1.02	0.56	
2 foot Grabs				
Point 4-4	<0.01	0.11	<0.01	
Point 4-6	0.13	0.98	4.69	
3 foot Composite	<1.0	28.7	41.8	
3 foot Grabs				
Point 4-2	2.55	0.58	0.57	
Point 4-4	0.06	0.06	<0.01	
Point 4-5	0.14	14.4	50.7	
4 foot Composite	1.05	0.30	0.19	

Unless otherwise noted, aldrin, endrin, dieldrin and heptachlor were not detected in any of the samples.

Analyses conducted by Craven Laboratories, Austin, Texas.

TABLE 3-5

SECTOR 5

Sample Identification	ppm BHC	DDT	Toxaphene	Other
Surface Composite	630	1,600	2,900	
Surface Composite A (West of fence)	0.06	1.93	2.24	
Surface Grabs				
Point 5-10	<0.01	0.25	0.34	
Point 5-11	<0.01	0.10	0.10	
Point 5-12	<0.01	0.06	0.02	
6 inch Composite	1.2	10	16	2.8 (Dieldrin)
1 foot Composite	1.7	59	100	
1 foot Grabs				
Point 5-2	0.05	0.29	<0.01	
Point 5-3	0.17	1.42	0.64	
Point 5-5	<0.01	<0.01	<0.01	
Point 5-6	0.06	0.03	<0.01	
Point 5-8	<0.01	0.59	1.77	
2 foot Composite	<0.01	0.06	0.03	
3 foot Composite	0.03	0.30	0.31	
4 foot Composite	0.04	0.17	0.13	

Unless otherwise noted, aldrin, endrin, dieldrin and heptachlor were not detected in any of the samples.

Analyses conducted by Craven Laboratories, Austin, Texas.

TABLE 3-6

SECTOR 6

Sample Identification	ppm BHC	DDT	Toxaphene	Other
Surface Composite	2,200	3,900	2,800	
6 inch Composite	<200	7,900	14,000	1,900 (Dieldri
1 foot Composite	320	1,900	3,200	480 (Dieldri
2 foot Composite	56.1	531	431	
2 foot Grabs				
Point 6-2	0.03	<0.01	<0.01	0.03 (Dieldrin)
Point 6-4	<0.01	<0.01	<0.01	
Point 6-5	<0.01	1.03	0.66	
Point 6-6	188	8,970	8,440	
3 foot Composite	0.04	0.07	0.04	

Unless otherwise noted, aldrin, endrin, dieldrin and heptachlor were not detected in any of the samples.

Analyses conducted by Craven Laboratories, Austin, Texas.

TABLE 3-7

SECTOR 7

Sample Identification	ppm BHC	DDT	Toxaphene	Other
2 foot Composite	152	270	<15	
2 foot Grabs				
Point 7-2	0.10	0.10	<0.01	
Point 7-3	0.29	7.44	<0.10	
Point 7-5	8,900	15,000	<250	
Point 7-6	1.03	9.48	6.60	
3 foot Composite	3.84	2.84	<0.25	
3 foot Grabs				
Point 7-5	0.89	0.71	0.35	
Point 7-6	0.09	0.81	0.26	
4 foot Composite	<0.01	0.45	<0.01	

Unless otherwise noted, aldrin, endrin, dieldrin and heptachlor were not detected in any of the samples.

Analyses conducted by Craven Laboratories, Austin, Texas.

TABLE 3-8

SECTOR 8

Sample Identification	ppm BHC	DDT	Toxaphene	Other
3 foot Composite	9,900	10,400	<1,000	
3 foot Composite Rerun	10,400	10,300	<1,000	299 (Aldrin)
3 foot Grabs				
Point 8-4	11,000	8,200	<250	250 (Aldrin)
Point 8-4 Rerun	11,800	8,260	<250	211 (Aldrin)
Point 8-6	0.08	3.82	1.33	
4 foot Composite	0.08	0.40	<0.01	

Unless otherwise noted, aldrin, endrin, dieldrin and heptachlor were not detected in any of the samples.

Analyses conducted by Craven Laboratories, Austin, Texas.

TABLE 3-9

SECTOR 9

Sample Identification	ppm BHC	DDT	Toxaphene	Other
Surface Composite A (East of road)	<0.50	36.0	28.0	
Surface Grabs				
Point 9-10	<0.02	4.59	<0.03	
Point 9-11	0.01	1.82	1.75	
Point 9-12	<0.01	0.23	0.23	
1 foot Grabs				
Point 9-2	<0.05	10.7	9.38	
Point 9-3	<0.25	5.00	0.75	
Point 9-5	0.08	14.1	15.0	
Point 9-6	<0.02	0.98	3.52	
Point 9-7	<0.02	<0.02	8.03	
Point 9-8	<0.01	0.08	0.08	
Point 9-9	<0.01	1.00	0.60	
Point 9-9	<0.01	.094	0.56	
Point 9-10	<0.01	0.11	0.07	
2 foot Composite	0.06	0.88	0.21	
3 foot Composite	0.05	0.45	0.13	
4 foot Composite	0.09	0.88	0.91	

Unless otherwise noted, aldrin, endrin, dieldrin and heptachlor were not detected in any of the samples.

Analyses conducted by Craven Laboratories, Austin, Texas.

TABLE 3-10

SECTOR 10

Sample Identification	ppm			
	BHC	DDT	Toxaphene	Other
Surface Composite	2,400	7,700	5,800	
Surface Composite A (East of road)	<0.25	13.4	5.00	
Surface Grabs				
Point 10-10	<0.25	17.5	11.4	
Point 10-11	<0.02	3.88	3.78	
Point 10-12	<0.01	0.72	1.12	
1 foot Grabs				
Point 10-2	<0.01	0.11	<0.01	
Point 10-4	0.38	0.23	<0.01	
Point 10-5	<0.01	<0.01	<0.01	
Point 10-6	<0.01	<0.01	<0.01	
Point 10-7	<0.01	0.02	<0.01	
Point 10-8	<0.01	0.09	0.05	
Point 10-9	<0.01	1.44	0.82	
2 foot Composite	0.01	0.04	<0.01	
3 foot Composite	0.26	0.05	<0.01	
4 foot Composite	<0.01	0.07	<0.01	

Unless otherwise noted, aldrin, endrin, dieldrin and heptachlor were not detected in any of the samples.

Analyses conducted by Craven Laboratories, Austin, Texas.

TABLE 3-11

SECTOR 11

Sample Identification	BHC (ppm)	DDT (ppm)	Toxaphene (ppm)	Other (ppm)
Surface Grabs				
Point 11-A-1	<0.25	26.3	13.1	
Point 11-A-2	<0.05	2.80	0.53	
Point 11-A-3	<0.05	5.11	1.50	
Point 11-A-4	<0.01	37.5	<0.01	
Point 11-B-1	<3.0	614	<5.0	
Point 11-B-2	<0.02	4.48	<0.03	
Point 11-B-3	<0.01	0.25	<0.01	
Point 11-C-1	<0.05	44.5	<0.10	
Point 11-C-2	<0.01	1.24	<0.01	
Point 11-C-3	<0.01	0.27	<0.01	
Point 11-D-1	<10	1,390	<25	
Point 11-D-2	0.80	206	<0.50	
Point 11-D-3	<0.25	20.0	10.0	
Point 11-D-4	<0.25	41.5	23.2	
Point 11-E-1	<0.05	2.22	0.82	
Point 11-E-2	<0.01	1.55	0.53	
Point 11-E-3	0.01	0.19	0.13	
1 foot Grabs				
Point 11-A-1	<0.01	0.02	<0.01	
Point 11-B-1	<0.01	0.15	<0.01	
Point 11-C-1	<0.01	0.47	<0.01	
Point 11-D-1	<0.01	5.14	<0.01	
Point 11-D-2	<0.05	6.35	<0.10	
Point 11-E-1	<0.01	0.20	0.06	
2 foot Composite	24.4	1,150	<25	
2 foot Grabs				
Point 11-2	<0.01	0.85	<0.01	
Point 11-3	<100	3,940	<250	
Point 11-5	0.04	2.34	<0.01	
Point 11-6	<0.01	0.07	<0.01	
Point 11-B-1	<0.01	0.02	<0.01	
Point 11-D-1	<0.01	0.08	<0.01	
Point 11-D-2	<0.01	0.24	<0.01	

TABLE 3-11 (Continued)

SECTOR 11 (Cont.)

Sample Identification	ppm BHC	DDT	Toxaphene	Other
3 foot Composite	0.13	0.56	<0.01	
3 foot Grabs Point 11-D-1	<0.01	0.18	<0.01	

Unless otherwise noted, aldrin, endrin, dieldrin and heptachlor were not detected in any of the samples.

Analyses conducted by Craven Laboratories, Austin, Texas.

TABLE 3-12

OTHER SAMPLES

Sample Identification	ppm BHC	DDT	Toxaphene	Other
Surface Composites				
AA	0.04	0.21	0.28	
BB	<0.01	0.54	0.40	
Surface Backgrounds				
1	<0.01	0.08	0.19	
2	<0.01	0.08	0.22	
3	<0.01	0.06	0.16	
1 foot Backgrounds				
1	<0.01	<0.01	<0.01	
2	<0.01	<0.01	<0.01	
3	<0.01	<0.01	<0.01	
Soil Samples Collected During Monitoring Well Drilling				
MW-2 Deep at 5.5 ft.	<0.01	0.03	0.01	
MW-2 Deep at 6 ft.	<0.01	<0.01	<0.01	

Unless otherwise noted, aldrin, endrin, dieldrin and heptachlor were not detected in any of the samples.

Analyses conducted by Craven Laboratories, Austin, Texas.

surface composite. Below 1 foot the pesticide concentrations became very low. West of the fence, surface levels of DDT and toxaphene were below 1.5 ppm at 5 feet from the fence.

In Sector 3, significant levels of BHC, DDT, toxaphene and dieldrin were observed in the surface samples. Below 6 inches, only BHC and DDT were detected. At 3 feet, values were below 1 ppm at locations 3-2, 3-5, and 3-6. West of Sector 3, the surface pesticide values (Composite A) were below 10 ppm near the fence. The concentrations decreased to below 1 ppm 25 feet from the fence at location 3-10. The 1 foot deep grab samples near the fence exhibited values below 1 ppm.

BHC, DDT, toxaphene, and dieldrin were all found in the surface and 6 inch composites of Sector 4. At location 4-5, significant concentrations continued down to 3 feet. At 5 feet west of the fence, surface levels of pesticides were below 4 ppm. Further west the grab samples concentrations were less than 1 ppm.

In Sector 5, BHC , DDT, and toxaphene, were present in high levels (above 600 ppm) on the surface. Significant concentrations extended only to a depth of one foot. Immediately west of the fence, values for the surface samples of individual pesticides were below 3 ppm.

Sector 6 samples exhibited significant levels of four pesticides down to a depth of 1 foot. Location 6-6 still contained high concentrations at 2 feet. At 3 feet all the pesticides were below 1 ppm.

In Sector 7, the 2 foot composite contained BHC and DDT over 150 ppm. Sample location 7-5 exhibited higher values than the other samples. Less than 10 ppm of BHC, DDT and toxaphene was present in the 2-foot deep samples and below.

Sector 8 exhibited composite sample values of BHC and DDT greater than 9000 ppm down to 3 feet. Some aldrin was also found in this sector. The 4-foot composite sample had less than 1 ppm total pesticides.

DDT and toxaphene were found in Sector 9 at levels of 15 ppm or less at the 1-foot depth. At the two foot depth, individual values were less than 1 ppm. To the east of Sector 9, Surface Composite A contained less than 50 ppm each of DDT and toxaphene. All 1-foot samples to the east of Sector exhibited less than 1 ppm except 9-7, which contained 8.03 ppm toxaphene.

Pesticide levels in the Sector 10 surface composite were above 2000 ppm, but were less than 1 ppm at 1 foot. To the east of Sector 10, values were less than 20 ppm at the surface and 2 ppm at 1 foot.

The primary pesticide found in Sector 11 was DDT. The 2 foot composite sample contained over 1000 ppm DDT, mostly from sampling point 11-3. Individual pesticide levels in the three foot composite were below 1 ppm. Transect lines were run to the north, east and south of Sector 11. These locations were labelled 11-A, 11-B , 11-C, and 11-D starting from the south and continuing to the north. Line E extended toward the east from sampling point 11-D-3. Samples from these transects showed that DDT and toxaphene are present above 1 ppm at the surface to the south and north of Sector 11. DDT is present to the east. Transect E had less than 3 ppm of DDT and toxaphene at the surface.

Two soil samples collected during the drilling of Monitoring Well 2-Deep were also analyzed. At the 5.5-foot. depth (Reference Table 3-12), only DDT and toxaphene were detected at 0.03 and 0.01 ppm respectively. At the 6 ft. depth, none of the pesticides were detected.

Sample AA collected at the surface 5 feet north of the site and sample BB collected at the surface 5 feet south of the site contained less than 1 ppm total pesticides.

3.3 Ground Water Investigation

3.3.1 Methods

During the week of August 16, 1984, three pairs of ground water monitoring wells were installed along the east and west sides of the site. The locations of these wells are shown in Figure 3-1. This drilling program was performed in order to:

1) determine subsurface stratigraphy;
2) collect subsurface soil samples;
3) determine water table elevations;
4) determine ground water flow direction; and
5) determine if pesticides were present in the shallow ground water.

The Area G site is situated on the Main Street Limestone Formation which is composed of three strata. The uppermost four to five feet of soil is composed of a very dark brown to black clay or marl. Underlying this clay is a calcareousrich caliche zone which ranges in thickness from two to five feet. The deepest strata is a dense limestone which contains sandy silt lenses. Figure 3-3 illustrates the generalized geology of the northwestern boundary of Area G which contains the pesticide site. The drilling logs are presented in Appendix A.

Locations for the pairs of monitoring wells were chosen based upon the site topography, the encountered stratigraphy and a review of borings logs for wells which were installed at an adjacent area at the NWIRP in 1981.

All borings for monitoring wells were completed using a truck mounted drill rig and mud rotary drilling method. In order to prevent down-hole contamination during the drilling process, the borings were cased with an eight-inch diameter PVC pipe which was installed to the top of the caliche layer. A 4:1 ratio cement/bentonite mix was tremmied into the annular space between the bore hole and the protection casing. Thus the completed well was sealed off from any potential pesticide effect from the upper soil strata. The remainder of each boring (and subsequent monitoring well) was completed 24 hours after the grout was installed by drilling through the center of the protective casing and into the lower strata.

All of the wells were installed with the following specifications:

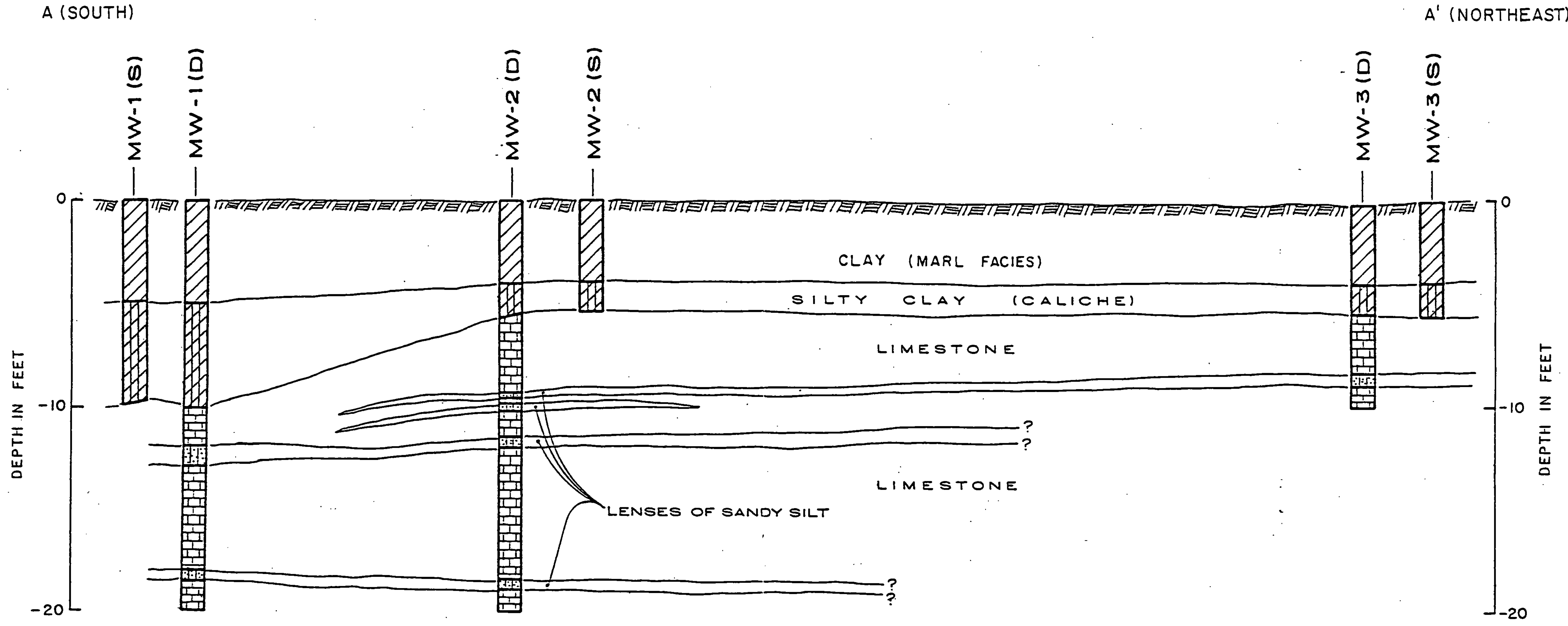
1) Schedule 40 PVC threaded riser with threaded cap, and 0.010 inch slot-size Schedule 40 PVC screen.

2) A sand pack extending one foot above the screened interval in each well.

3) A one-foot thick bentonite pellet seal was installed above the sand pack.

4) A 4:1 ratio cement/bentonite mix tremmied in the remaining annulus to the ground surface. A portland cement concrete base was placed around each well at the surface. An outer casing was placed over the well with a locking cap.

The top-of-casing (TOC) elevations were surveyed during the week of September 18, 1984 using an assumed bench mark elevation of 790 feet msl. This site bench mark was established based on ground contours shown in the NW/4 McGregor Quadrangle map (ASM 6546 IV NW-Series V882). Therefore the



KEY

LOWER CRETACEOUS MAIN STREET LIMESTONE FORMATION
- CLAY (MARL FACIES)
- SILTY CLAY
- SANDY SILT
- LIMESTONE

ZERO IS AT GROUND SURFACE

THE GROUND SURFACE IN THIS AREA VARIES LESS THAN 4 FEET

NO GROUND WATER WAS ENCOUNTERED

SCALES

VERTICAL 0–5; HORIZONTAL 0–50

FIGURE 3-3

GENERALIZED GEOLOGICAL CROSS-SECTION OF THE NORTHWESTERN BOUNDARY OF AREA G

ERM-Southwest, inc.
HOUSTON, TEXAS

assumed bench mark elevation is within one to two feet of the U.S. Geological Survey elevations. On this same date, the corner markers of the sectors were also surveyed.

The benchmark consists of two 18"-long stakes driven along side and nailed to the 12th fence post northeast of point F. The top of the stakes are approximately 1 inch above the ground. Point F is the northwest corner of the sampling grid (the corner post of the fence line).

Initial ground water observations indicated all monitoring wells were dry. The site was periodically visited for several months and ground water was not observed in any of the wells from August, 1984 to January, 1985. A summary of the static ground water measurements is presented in Table 3-13. The ground water in monitoring wells 1-D and 2-D was sampled on January 15, 1985. All other wells on the site were dry at that time. The depth to ground water was observed to be about 15 feet (778 msl) below the ground surface. Therefore, water would not be expected in any of the other wells since their casings do not extend to that depth.

In order to prevent cross-contamination of the wells during ground water sampling events, dedicated bailers were installed in and used for each well. All the water that could be bailed was removed from the wells at 9:00 am on January 15, 1985 and collected in new glass sample jars. Slightly more than one well volume was removed during this sampling operation. At 1:00 pm that afternoon, no significant volumes of ground water had reentered the two monitoring wells. Therefore, laboratory analyses were conducted on the only ground water that was collected.

3.3.2 Results

Table 3-14 presents the results of the laboratory analyses of the ground water samples that were collected. None of the pesticides were detected in the ground water samples. The detection limit was 1 ppb.

Rainfall data for the McGregor site is presented in Table 3-15. At the present time, there is insufficient data to indicate a definite correlation between shallow groundwater levels at the site and rainfall rates.

TABLE 3-13

Summary of Static Ground Water Measurements[a]

Area G NWIRP
McGregor, Texas

Well No.	Depth (feet)	January 15, 1985[b] TOC (ft)	SWL (ft)	Ground Water Elevation (ft)	February 27, 1985 TOC (ft)	SWL (ft)	Ground Water Elevation (ft)
1-D	21	797.00	18.27	778.73	797.00	18.32	778.68
1-S	9	796.78	Dry	—	796.78	Dry	—
2-D	20	794.74	16.50	778.24	794.74	16.05	778.69
2-S	9	795.75	Dry	—	795.75	Dry	—
3-D	10	793.49	Dry	—	793.49	Dry	—
3-S	5	793.29	Dry	—	793.29	Dry	—

TOC = Top of casing.

SWL = Distance from top of casing to static water level.

[a]elevation based on assumed BM of 790 feet msl.

[b]Before initial well development.

TABLE 3-14

Ground Water Results for Chlorinated Pesticides
(Aldrin, Dieldrin, Toxaphene, BHC,
Heptachlor, Endrin and DDT)

Location		Pesticide Concentration
MW-1 Deep	(Sample not shaken)	Not Detected
MW-1 Deep	(Sample shaken)	Not Detected
MW-2 Deep	(Sample not shaken)	Not Detected
MW-2 Deep	(Sample shaken)	Not Detected

The detection limit was 1 ppb.

Analyses by Craven Laboratories, Austin, Texas

TABLE 3-15

Monthly Precipation Data
Naval Weapons Industrial Reserve Plant- McGregor, Texas

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Yearly Total
75	2.00	4.00	1.50	4.55	11.40	2.20	2.60	3.25	4.25	2.50	1.45	1.95	41.65
76	1.70	0.40	3.40	5.25	4.00	4.90	5.80	0.80	5.84	6.50	0.70	5.10	44.39
77	3.50	4.00	3.53	7.50	2.00	4.50	0.00	2.20	2.90	1.60	2.00	0.20	33.93
78	2.20	3.30	2.75	2.25	4.15	3.80	0.80	1.40	3.40	2.45	10.20	2.10	38.80
79	6.50	5.00	8.05	1.40	11.50	6.50	2.50	3.45	3.70	2.50	0.60	4.70	56.40
80	2.40	3.70	3.55	5.20	9.00	1.50	0.00	0.00	4.70	1.07	0.29	4.00	35.41
81	1.30	2.50	4.80	1.95	5.00	9.90	2.90	3.80	2.90	7.60	1.20	1.20	45.05
82	3.30	1.80	3.60	4.60	3.80	3.20	1.30	0.00	0.10	2.30	5.20	3.90	33.10
83	2.80	5.90	6.20	0.00	6.70	2.70	2.80	6.20	1.00	2.00	1.40	1.10	38.80
84	1.30	0.40	3.20	1.00	2.10	3.40	1.20	1.20		11.9	4.8	5.5	
85	1.3	2.45											
Monthly Average	2.57	3.04	4.06	3.37	5.96	4.26	1.99	2.23	3.20	4.04	2.78	2.98	40.83

Note: Yearly Average Based on Data Compiled for Years 1975 through 1983

All Values are in Inches.

4 - DEFINITION OF REMEDIAL OBJECTIVES

4.1 Potential Pathways For Pesticide Migration

Five major pathways are possible for pesticide migration from the site to the surrounding environment. These pathways are:

1. Overland flow via stormwater run-off.

2. Percolation through soils to ground water, followed by off-site transport in the direction of the prevailing ground water gradient or vertically to deeper aquifers.

3. Ingestion of affected vegetation by domestic animals and/or wildlife.

4. Direct contact with affected soils by humans, livestock or wildlife.

5. Wind dispersal of airborne affected soils.

Pathway 1: Overland Flow

Based on the results of previous investigations of pesticide concentrations in surface soils and pond sediments near the site, the potential for overland transport of pesticides via stormwater has been shown to be negligible. In addition, site topography has such small vertical relief that the risk of future migration due to overland flow is also negligible. Therefore, this pathway will not be considered further.

Pathway 2: Ground Water

Monitoring wells have been installed at the site to sample the uppermost saturated zone. Total depth of the ground water monitoring wells is 20 feet from the surface. Water from these wells has been sampled and was found to contain no detectable levels of any of the pesticides (detection limit = 1 ppb).

Because the pesticide site has been in existence for at least 30 years, the lack of measurable concentrations of pesticides in the shallow ground water indicates that virtually no downward migration of pesticides has occurred. Testing of soils concentrations to a depth of 3 to 4 feet confirm that pesticides concentrations are rapidly attenuated within a few feet of the soil surface. Moreover, the Hensel regional aquifer used at the NWIRP lies at a depth of at least 960 feet below ground surface. Therefore, migration of pesticides off-site via this pathway will not be considered further.

Pathway 3: Ingestion of Contaminated Vegetation

Vegetation available on-site represents a very small percent of total forage available in the site region. Access to site forage will also be severely restricted during closure and post-closure care periods by fences. Given the insignificant risk posed by plant uptake of pesticides from site soils to domestic animals or wildlife, further evaluation of this pathway would not significantly add to the risk assessment. Therefore, this pathway will not be considered further.

Pathway 4: Direct Contact

Direct contact by humans or animals with affected soils is possible at the site. However, the pesticide site is completely enclosed by a fence and is not grazed. The remedial alternatives being considered include removal of affected soils or capping with 1 to 3 feet of clean soil to preclude direct contact. Moreover, published LD_{50} values for acute dermal exposure to the pesticides found at the site are well above the levels to which humans and animals might be exposed after remediation. Therefore, this pathway will not be considered further.

Pathway 5: Wind Dispersal of Airborne Soil

Wind dispersal of airborne affected soils could occur at the site under "worst case" conditions (i.e., bare, disturbed soil surfaces, drought conditions and high wind). Affected soils could be transported in the direction of prevailing winds to nearby human or animal populations. Exposure routes of concern for wind-carried pesticides would then include dermal and respiratory routes of entry to exposed individuals. This pathway is considered in detail in the following Section 4.2.

4.2 Previous Investigations

A precedent for a 10 ppm soil clean up level has been established by the EPA Administrator for the Aidex Corporation Site, Council Bluffs, Iowa. In the Record of Decision (ROD) for remedial alternative selection for the site (September 30, 1984), the Administrator ruled that "Soils in areas of the site contaminated to levels less than 10 ppm pesticides will be graded where necessary to promote drainage and seeded." No other remediation measures were recommended for soils with total pesticide concentrations less than 10 ppm. This ruling was based in part on published literature which documents residual soil pesticide concentrations ranging from 0.01 to 3.07 ppm (Carey, et al, PMJ 6(4): 369-376, March 1973). The clean-up of soils which exceed a total pesticide level of 10 ppm would assure that no single chemical is present at a level significantly higher than the residual concentrations resulting from the normal historical field application rates for (the) pesticides studied. "This criteria (sic) was developed recognizing that pesticide applications to control pests have not, in general, had an adverse impact on human health, soil microorganisms, or ground water quality" (Aidex ROD, Sept. 30, 1984).

A comparison was made between the Aidex Site and the NWIRP, McGregor Site concerning those factors that would affect environmental releases. The factors compared included the physical location, rainfall quantity, susceptability to flooding, soil types, and types of pesticides at each of the two sites.

The Aidex Site is located in Mills County, Iowa along the banks of the Missouri River. Topography of the Aidex Site is relatively flat. The Aidex Site is subject to flooding from local runoff. The annual rainfall of about 28 inches per year at Aidex is similar to 32 inches per year at McGregor.

The McGregor Site is also relatively flat with very little topographic relief. There has been no known flooding at the McGregor Site and no future flooding is expected. Therefore, the risk of environmental releases of pesticides due to flooding is much lower at the McGregor Site than at the Aidex Site.

The soil at the McGregor Site contains much more clay than the Aidex Site and therefore has a much higher adsorptive capacity to retain pesticides.

Pesticides present at the Aidex Site include: organochlorines such as heptachlor, toxaphene, chlordane, methoxychlor, DDT, aldrin, dieldrin, and lindane; organophosphates such as phorate, diazinon, disulfoton, chlorpyrifos, and ethoprop; and triazine herbacides atrazine and prometon.

Pesticides in soils at the McGregor Site after initial remedial actions, however, included only five of the organochlorines listed above (BHC-Lindane, DDT, Toxaphene, Dieldrin, and Aldrin. The oral toxicity (mg/kg) and exposure toxicity (TWA) in mg/m^3 of the three major organochlorine compounds found at McGregor (toxaphene, BHC-Lindane, and DDT) are approximately one-half to one-tenth of the toxicity of the three of the major organophosphates found at Aidex (phorate, ethoprop and disulfoton).

In summary, the site-specific factors concerning the release of pesticides to the environment indicate lower expected releases at McGregor than at Aidex. The 10 ppm soil pesticide remediation level that is adequate for Aidex should therefore be more than adequate at the NWIRP, McGregor Site.

4.3 Wind Dispersal of Contaminated Soils

Based on a review of the recent soil analyses (Section 3, results for soil samples taken after initial removal actions) at the site, the following maximum values for selected pesticides have been found:

Pesticide	Soil Concentration (ppm)	Location
DDT	28,000	Sector 4, Surface Composite
Toxaphene	50,000	Sector 4, Surface Composite
BHC	16,000	Sector 3, Surface Grab

4.3.1 Worst-Case On-Site Exposure Calculation

Detailed calculations for maximum site exposure levels were made and incorporated in the "Health and Safety Program" (ERM-Southwest, July 2, 1984) for the initial remedial soils removal performed in August, 1984. A maximum probable soil-in-air loading of 100 mg soil per cubic meter of air (0.1 g/m^3) was assumed based on EPA-developed criteria for probable dust loads resulting from heavy vehicular traffic on dry dirt road surfaces. ["Compilation of Air Pollution Emission Factors" EPA Document AP-42, May 1978].

The calculated maximum airborne concentration of the above pesticides all occurring at the same place and time was then calculated as follows:

@ dieldrin clean up to 10 ppm remaining in soil

Worst Case Airborne Pesticide Concentration

$$= (0.1 \text{ g soil/m}^3 \text{ air}) \times \text{mg pesticide/kg soil} \times \frac{1 \text{ kg soil}}{1000 \text{ g soil}}$$

$$= 10^{-4} \times (\text{mg pesticide/m}^3 \text{ air})$$

kg soil

For DDT,	$(28{,}000 \text{ mg/kg})(10^{-4})$	=	2.8 mg/m^3
For BHC,	$(16{,}000 \text{ mg/kg})(10^{-4})$	=	1.6 mg/m^3
For Toxaphene	$(50{,}000 \text{ mg/kg})(10^{-4})$	=	5.0 mg/m^3
Total =	$94{,}000 \text{ mg/kg}$	=	9.4 mg/m^3, say 10 mg/m^3

Estimated Maximum Total Pesticide Concentration = 10 mg/m^3 → in air

These levels are equivalent to worst-case on-site conditions that might be encountered during remedial actions or other conditions (i.e., severe windstorm) which might result in significant site emission of fugitive dust.

4.3.2 Short Term Exposure

Using TLVs (Threshold Limit Value - the time-weighted average concentration for a normal 8-hour workday and a 40-hour work week to which nearly all workers may be repeatedly exposed, day after day, without adverse effect) for Toxaphene, DDT, heptachlor, BHC, and dieldrin (all of which have been detected in soils on-site), a maximum "safe" concentration for total pesticides in soils on-site can be calculated.

The TLVs as published by the American Conference of Governmental Industrial Hygenists (1984-1985) for these compounds are:

Toxaphene	0.5 mg/m^3
DDT	1.0 mg/m^3
lindane	0.5 mg/m^3
dieldrin	0.25 mg/m^3

Using the TLV for dieldrin as the most conservative case, the maximum total pesticide concentrations that would be acceptable for soils on site would be:

$$0.25 \text{ mg/m}^3 \times 10^4 = 2500 \text{ mg/kg dieldrin remaining in the soil.}$$

Residual soil concentrations of 10 mg/kg would result in maximum on-site airborne concentrations of only 0.001 mg/m^3 of total pesticides. This airborne concentration is significantly lower than the worst case TLV. Therefore, clean up of soils to a level of 10 ppm would clearly be sufficient to avoid adverse effects to human health or the environment due to airborne contaminated soils on-site.

4.3.3 Worst-Case Off-Site Exposure Calculation

The two human populations nearest to the disposal area are the NWIRP work area located about 3000 feet (910 meters) east of the disposal area, and the City of McGregor, Texas, located about 12,500 feet (3800 meters) northeast of the site as shown in Figure 2-1. Two different Threshold Limit Values (TLVs) were assumed for these two areas. A "worst case" exposure time equivalent to a 40-hour work week is assumed for the NWIRP work area. The corresponding published TLV (maximum level for no adverse effect) for this exposure level is 0.5 mg/m^3 for Toxaphene.

A 24-hour, 7-day/week "worst case" exposure time has been assumed for the City of McGregor. No published TLV for this exposure level is available. A factor of 40 hours/week divided by 168 hours (24 hours x 7 days) was used to modify the published TLV. The resulting calculations found an acceptable concentration of 0.12 mg/m^3 for this level of exposure.

A dispersion model developed by Cowherd, et al (1984)[a] can be used to calculate worst-case-exposure air concentrations of the most concentrated pesticide (toxaphene at 50,000 mg/kg) for these two populations. During similar investigation at a site in Arkansas, EPA used their model to predict dioxin concentration for a 2.5 acre source area with a maximum dioxin concentrate of 14 ppm in soils (Falco and Schaum,[b] May 23, 1984). Using the model assumptions and results as stated in this report and assuming a source concentration of 50,000 mg/kg soils, the following concentration was calculated:

[a]Cowherd, C., G. Muleski, P. Englehart, and D. Gillette. 1984. Draft. "Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination Sites". EPA Contract No. 68-01-3116. April 20, 1984.

[b]Falco, J.W. and J.L. Schaum. "Assessment of Risk Caused by Remedial Actions Considered For Vertac Chemical Corporation Site, Jacksonville, Arkansas" May 23, 1984.

Assumptions

Case I: Source concentration = 50,000 mg/kg for Toxaphene
Case II: Source concentration = 100,000 mg/kg for total pesticides
Model: Source concentration = 14 mg/kg (dioxin)

Therefore, concentration factor used to convert model results to McGregor Site results

$$= \frac{50,000}{14} = 3600 \text{ (Toxaphene)}$$

$$\text{or} \quad \frac{100,000}{14} = 7100 \text{ (total pesticides)}$$

Results:

	Source Concentration	Airborne Concentration (ug/m^3) at Distance: 250m	290m	435m	580m
Model	14 mg/kg	$8x10^{-6}$	$6x10^{-6}$	$4x10^{-6}$	$3x10^{-6}$
Case I	50,000 mg/kg	0.029	0.021	0.014	0.011
Case II	100,000 mg/kg	0.057	0.043	0.029	0.021

Using the TLV for dieldrin (0.25 mg/m^3 or 250 ug/m^3) as the most conservative case for assessment of risk, the total pesticide concentration 580 m (approximately 2,000 feet) from the site would be 11,900 times lower than the recommended level for no adverse effect for a 40 hour work week. Similarly, toxaphene concentration at 2000 feet would be 45,450 times lower than the toxaphene TLV of 0.5 mg/m^3 (500 ug/m^3). Since the two nearest populations at risk are 3000 feet (NWIRP work area) and 12,500 feet (City of McGregor) from the site, the risk to human health from exposure to airborne fugitive dust from the site is obviously negligible. Therefore, soil clean-up to a level of 10 ppm (1/10,000th of the worst case assumption) is more than sufficient to protect human health and the environment. The soil clean-up to 1/10,000th of the worst case assumption will result in air pesticide concentrations at the property line that will be lower than 0.1% of the TLV. This percentage is the most stringent rule-of-thumb used by Texas Air Control Board (TACB) to consider waste sites. Therefore the TACB would not consider this site any further for air emissions.

4.4 Defining Remedial Objectives

A precedent Record of Decision (ROD) was established by the EPA Administrator for the Aidex Corporation Site in Council Bluffs, Iowa defining a 10 ppm pesticide in soil clean-up level.

The EPA Administrator ruled on September 30, 1984 that "Soils in areas of the site contaminated to levels less than 10 ppm pesticides will be graded where necessary to promote drainage and seeded". No other remediation measures were recommended for soils with total pesticide concentrations less than 10 ppm. He further ruled in the same ROD that "This criteria (sic) was developed recognizing that pesticide applications to control pests have not, in general, had an adverse impact on human health, soil microorganisms, or ground water quality."

Worst-case projections of airborne total pesticide concentrations on-site during remedial actions or severe wind storms were estimated to be 10 mg/m^3. Using an EPA air dispersion model (Cowhead, et al, 1984) as applied to a site in Arkansas (James W. Falco and John L. Schaum, May 23, 1984), a worst-case on-site airborne concentration of 10 mg/m^3 was found to return to levels below 0.01 ug/m^3 within 2000 feet of the site. Recommended TLV for site pesticides (based on dieldrin) are $\geq$ 0.25 mg/m^3, a level approximately 25,000 times the calculated concentration of 0.01 ug/m^3 at 2000 feet from the source. Moreover, the distance to the nearest human population at risk is 3000 feet (NWIRP work area) and, to the nearest town (City of McGregor) 12,500 feet.

In summary, clean-up or isolation of soils to a concentration of 10 ppm or less should be more than adequate to protect the environment and minimize human exposure at the Area G site.

5 - REMEDIAL ALTERNATIVES ANALYSIS

5.1 Description of Alternatives

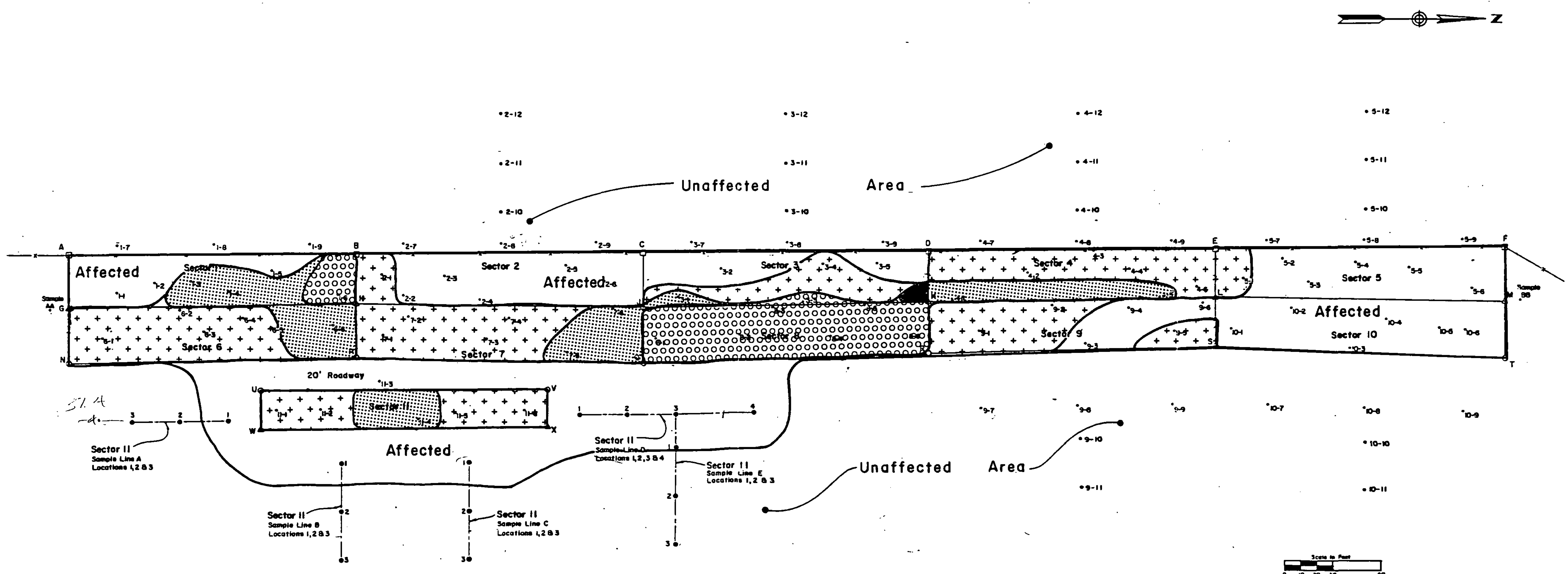
In the previous section, the single Remedial Objective for the Area G pesticide site was determined to be the remediation and/or isolation of soil containing total pesticide concentrations greater than 10 ppm. The areal extent and depths of soil containing total pesticides at 10 ppm and higher is illustrated in Figure 5-1. The total volume of the affected soil at 10 ppm and above was estimated to be 4,125 cubic yards.

Six alternatives will be evaluated to fulfill the requirements of the Remedial Objective. Those six alternatives are:

1. Excavation, transportation to and disposal in a licensed commercial Class I landfill.
2. Partial consolidation of the affected soil into a smaller area, constructing side berms and a low permeability cap.
3. An on-site hazardous waste landfill satisfying RCRA requirements.
4. A low permeability cap covering all the waste in place (no excavation).
5. A soil cover which will be a minimal action alternative.
6. Biological treatment of the affected soil in combination with some of the other five alternatives.

Each of the six alternatives will be defined by critical concept criteria such as cross sectional sketches and design features, permeabilities of caps, surface slopes, potential off-site landfills, excavation methods, final grass covers and long-term security measures. Each of the alternatives will then be evaluated based on associated environmental risks and human exposure, technological feasibility, reliability, long-term maintenance and monitoring, and estimated cost. For the purpose of analysis, 30 years was considered the long-term period for maintenance.

At the conclusion of the alternative analysis, a best single remediation alternative for the affected soil will be recommended.



Area Affected At The Surface

Area Affected At A Depth Of 1 Foot

Area Affected At A Depth Of 2 Feet

Area Affected At A Depth Of 3 Feet

Area Affected At A Depth Of 4 Feet And Deeper

Plan View Of Affected Soil

AREA G PESTICIDE SITE - NWIRP
McGREGOR, TEXAS

ERM-Southwest, Inc.
HOUSTON, TEXAS

Scale 1" = 60'
Drawn DP
Checked HL
File No. 53-01

FIGURE 5-1

All costs included in this report are in terms of June 1985 dollars.

5.1.1 Alternative 1: - Excavation and Off-Site Landfilling

This alternative includes the excavation of 4,125 (in place) cubic yards of affected soil, loading the material onto semi-truck trailers, hauling to and disposing in a licensed commercial hazardous waste landfill. The excavation was estimated to be accomplished by a track mounted backhoe with a 3 1/2 cubic yard bucket. It was estimated that portable scales would be used on-site to check the axle weights and to obtain maximum legal loads. A limited amount of water spray was included for dust control during excavation. The soil excavation would be accomplished to the depths and limits in accordance with Figure 5-1.

Plastic "baggie" liners were included to ensure that none of the load would be lost in transit. On top of the enclosed baggie, canvas tarps were included to cover the truck trailers.

The truck loads were estimated to have a payload of 22 net tons. Truck hauling costs were estimated at $3.10 per loaded truck mile.

Two landfills were considered for disposal - the Chemical Waste Management Landfills in Emelle, Alabama and in Sulfur, Louisiana. Both landfills agreed they would accept the pesticide waste including toxaphene. The distance from McGregor, Texas to Sulfur, Louisiana was estimated to be 394 miles one way. This distance is 199 miles closer than the 593 miles one way to Emelle, Alabama. The estimated transportation savings of $617 per load more than offsets any Louisiana disposal taxes and/or additional disposal costs at the Sulfur site. Disposal costs were quoted at $65 per ton (after July 1, 1985) by Chemical Waste Management. Louisiana disposal taxes equal $10 per ton. The Superfund tax equals $2.13 per ton.

It was estimated that three residual soil samples would be collected twice from each of the 11 sectors and analyzed for pesticides.

The capital costs for Alternative 1 are listed in Table 5-1. The long-term maintenance and monitoring costs are included in Table 5-2. Since the remediated area will be covered with a clean soil fill, it was estimated that no land would be held from active agricultural production. Therefore, no additional fencing will be required.

TABLE 5-1

Capital Costs - Alternative 1

Mobilization, Demobilization, Scales and Safety Equipment	$ 9,600
Excavation and Loading Costs 4,125 c.y. @ $3.00	12,400
Truck Demurrage 253 hours @ $45.00	11,400
Hauling Costs including Baggies 253 Loads @ $1300.00	329,000
Disposal Costs including Taxes 5570 tons x $77.13/ton	430,000
Residual Soil Pesticide Analyses 66 samples @ $210.00	13,900
Backfill Excavated Areas 4125 c.y. @ $4.00	16,500
Seed and Fertilize 2 Acres @ $1000.00	2,000
Subtotal	$ 825,000
20% Contingency	165,000
Subtotal	$ 990,000
15% Contractors Overhead & Profit	149,000
Subtotal	$1,139,000
15% Engineering & Construction Surveillance	171,000
Total Capital Cost - Alternative 1	$1,310,000

TABLE 5-2

Long Term Maintenance and Monitoring Costs: Alternative 1

Ground Water Sampling 1 technician @ 8 hrs/yr. x $45/hr. x 3 yrs.	=	1,100
Ground Water Analysis 4 samples x 3 yrs @ $210 each	=	2,500
Reporting 1 engineer @ 8 hrs/yr. x $45/hr. x 3 yrs.	=	1,100
Total Long Term Maintenance and Monitoring		$ 4,700
	say	$ 5,000

Total costs for this alternative are summarized as follows:

Total Capital Costs	$1,310,000
Total Long Term Maintenance and Monitoring Costs	5,000
Total Land Costs	-0-
Total Costs - Alternative 1	$1,315,000

*Based on the assumption that interest and inflation are roughly equivalent.

5.1.2 Alternative 2 - Partial Consolidation, Side Berms and Cap

This alternative includes the excavation of 1400 in place cubic yards of affected soil from Sections 4, 5, 9, 10 and 11 and consolidating this waste under a low permeability cap. The cap will cover Sections 1, 2, 3, 6, 7 and 8 as shown in Figure 5-2. A track mounted backhoe with a 3 1/2 c.y. bucket was used for estimating the excavation costs for the contaminated soil. Dump trucks will be used to transport and spread the soil. A water spray will be used for dust control during earthwork operations.

The consolidated waste area will be surrounded by 3 to 5 foot compacted earthen berms and covered by a 5.5 foot thick composite low permeability cap. The composite cap will consist of six inches of topsoil, 18 inches of borrowed fill, six inches of sand, a 30-mil HDPE geomembrane, and three feet of recompacted clay as shown in Figure 5-3. The slope of the cap will be 2.5 percent. The permeability of the clay layer will be $1x10^{-7}$ cm/sec or less. Recent physical testing of the on-site soils indicate that a recompacted permeability of 1 X 10^{-9} cm/sec can be achieved under laboratory conditions. This information may be referenced in Appendix B.

Costs for seeding the cap and fencing the entire area were included in the cost estimate. Areas which will be excavated for consolidation will be sampled and tested for residual pesticides. Thirty samples were estimated to be required for this alternative. Fill required to backfill the excavated areas, after sampling, will be borrowed from adjacent areas. Irrigation pipe and stormwater diversion structures were also included in the estimate.

The capital costs for Alternative 2 are listed in Table 5-3. Long-term (30 year) maintenance and three year ground water monitoring costs are included in Table 5-4. Less than two acres will be taken out of agricultural use with a value of $1200 per acre for a land cost of $2400.

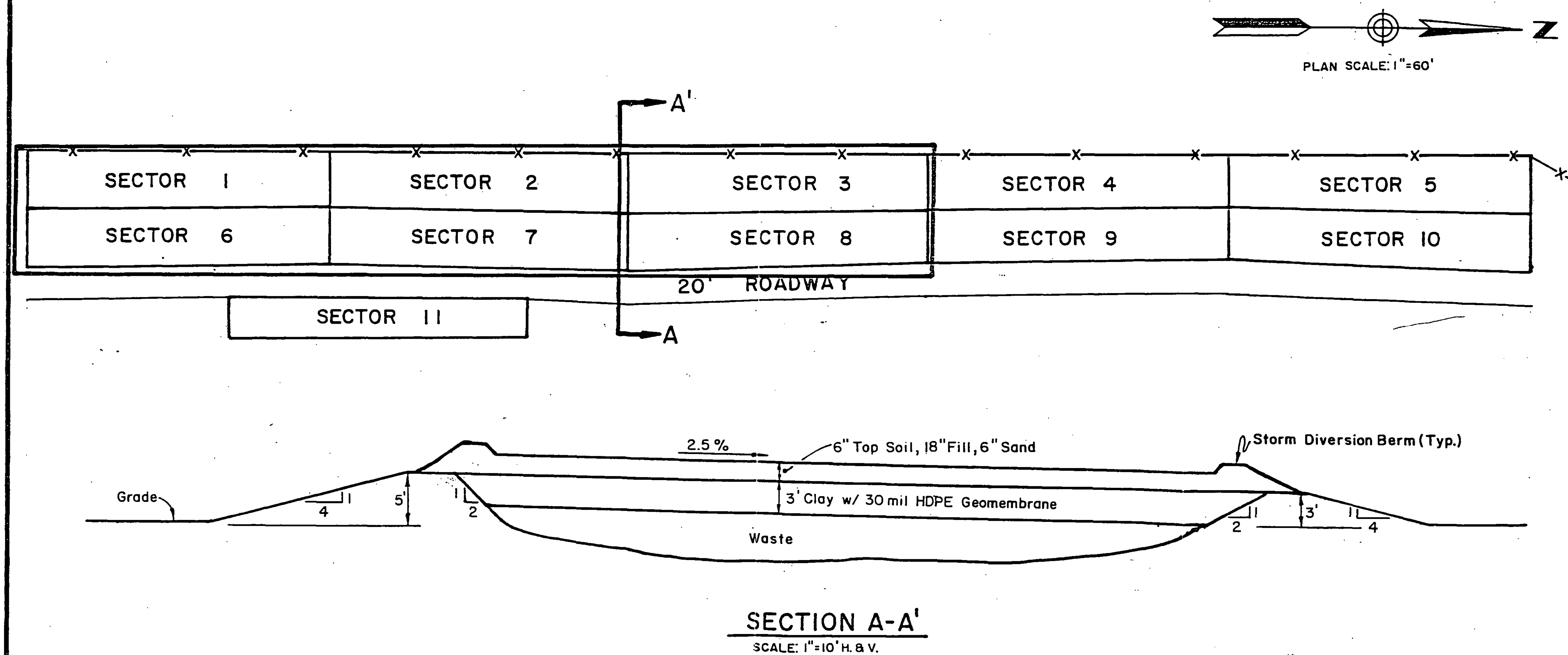


FIGURE 5-2
ALTERNATIVE 2

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Houston, Texas

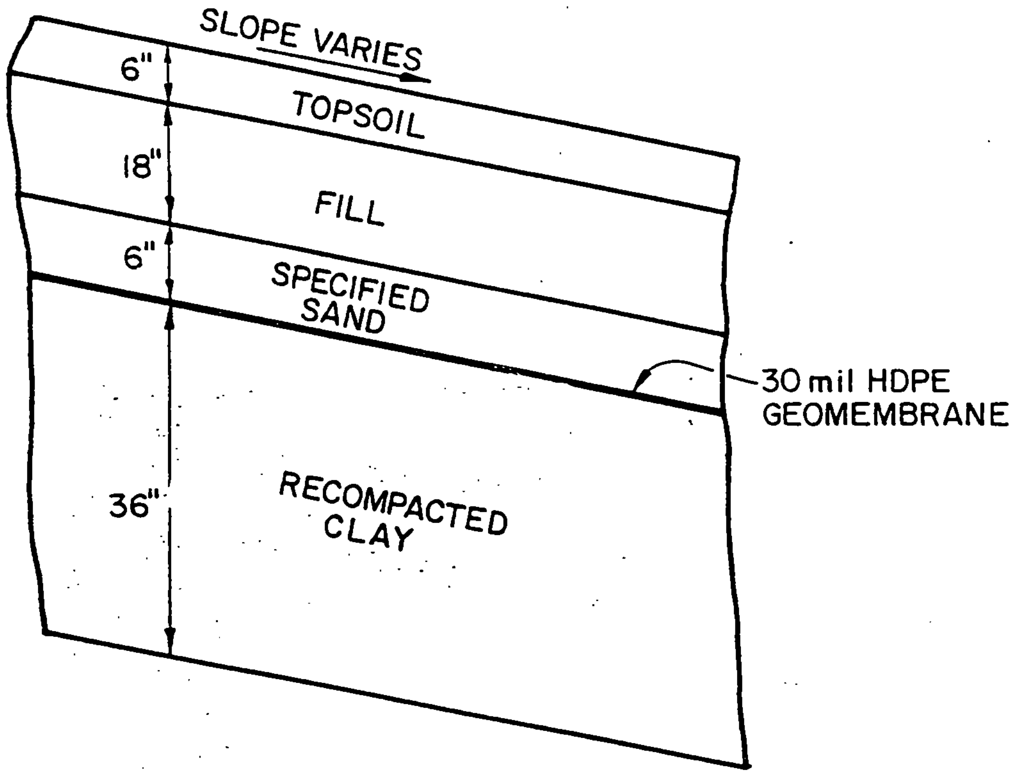

FIGURE 5-3
TYPICAL COMPOSITE CAP LAYER

ERM-Southwest, inc.
Houston, Texas

TABLE 5-3

Capital Costs - Alternative 2

Mobilization, Demobilization and Safety Equipment	=	$ 8,000
Consolidate Waste 1400 c.y. @ $3.00/c.y.	=	4,200
Regrade and Compact Site to be Capped 2500 c.y. @ $2.00/c.y.	=	5,000
Construct Berms 4000 c.y. @ $4.00/c.y.	=	16,000
3' Clay Cap 4200 c.y. @ $4.50/c.y.	=	18,900
30 mil HDPE Geomembrane 45,400 sq. ft. @ $0.45/sq. ft.	=	20,400
6" Sand Drainage Layer 840 c.y. @ $10.00/c.y.	=	8,400
18" Cap Fill 2520 c.y. @ $3.70/c.y.	=	9,300
6" Topsoil 815 c.y. @ $6.00/c.y.	=	4,900
Seed and Fertilize 7900 sq. yd. @ $1.00/sq. yd.	=	7,900
Fencing - 6 foot high chainlink, 3 strand barbed wire, vehicle and pedestrian gates	=	16,600
Irrigation Pipe Rental for Dust Control	=	2,000
Stormwater Diversion Structures 4 @ $2500	=	10,000
Residual Soil Pesticide Analyses - 30 @ $210 each	=	6,300

TABLE 5-3 (Continued)

Backfill Excavated Areas with Fill Borrowed From Adjacent Areas and Grade Fill 1400 c.y. @ $4.00/c.y. =	5,600
Subtotal	$144,000
20% Contingency	29,000
Subtotal	173,000
15% Contractors Overhead & Profit	26,000
Subtotal	199,000
20% Engineering and Construction Surveillance	40,000
Total Capital Cost - Alternative 2	$239,000

TABLE 5-4

Long Term Maintenance and Monitoring Costs: Alternative 2

Visual inspection, benchmarks inspection and periodic survey 1 technician @ 16 hrs/yr. x $45/hr x 30 yrs.	= $ 21,600
Maintenance (cap, monitor wells) 2 workers @ 40 hrs/yr each x $25/hour x 30 yrs	= 60,000
1 backhoe @ 8 hrs/yr x $45/hour x 30 yrs	= 10,800
5 truckloads soil or clay x 8 cu.yd./ truckload x $5.00/cu.yd. x 30 yrs	= 6,000
Mowing 2 days/year @ $600 a day x 30 yrs	= 36,000
Seed and fertilize 1 day/yr. @ $600/day x 30 yrs	= 18,000
Ground water sampling 1 technician @ 8 hrs/yr x $45/hr x 3 yrs	= 1,100
Ground water analysis 4 samples/yr @ $210 ea. x 3 yrs	= 2,500
Reporting 1 engineer @ 8 hrs/yr. x $45/hr x 3 yrs	= 1,100
Total Long Term Maintenance and Monitoring Costs	$157,100
	say $157,000

Total costs for this alternative are summarized as follows:

Total Capital Costs	$239,000
Total Long Term Maintenance and Monitoring Costs	157,000*
Total Land Costs	2,400
Total Costs - Alternative 2	$398,400
	say $398,000

* Based on the assumption that interest and inflation rates are roughly equivalent.

5.1.3 Alternative 3 - On-Site Hazardous Waste Landfill

Alternative 3 includes the excavation of 4,125 in-place cubic yards of contaminated soil, via a 3 1/2 cu.yd. bucket, track-mounted backhoe. This waste will then be placed into a newly constructed on-site landfill which will satisfy all current RCRA requirements as shown in Figure 5-4. A water spray will be used for dust control during earthwork operations.

The landfill will be an above grade landfill surrounded by seven foot high dikes, with a minimum width of eight feet. It will have 4:1 outside slopes and 2:1 inside slopes. The landfill will be covered with a 5.5 foot thick composite cap consisting of six inches of topsoil, 18 inches of fill, six inches of sand, a 30 ml HDPE geomembrane and three feet of recompacted clay. The clay will have a permeability of at least 1 X 10^{-7} cm/sec. On-site soils, which will be used for the cap, have shown through physical testing to attain laboratory recompacted permeabilities of 1 X 10^{-9} cm/sec. The cap will be sloped at four percent.

The landfill will have a composite bottom liner designed and constructed in accordance with current RCRA regulations. The five foot bottom liner will consist of: non-woven geofabric to prevent downward migration of the waste into the leachate collection system, 12 inches of sand containing the primary leachate collection pipes, a 60 ml HDPE geomembrane, 12 inches of sand containing the secondary leachate collection pipes, another 60 ml HDPE geomembrane and three feet of recompacted clay with at least the same permeabilities as the clay used in the cap.

Areas with affected soil which have been excavated for disposal in the new landfill will be sampled and tested for residual pesticides. Sixty-six samples were estimated to be

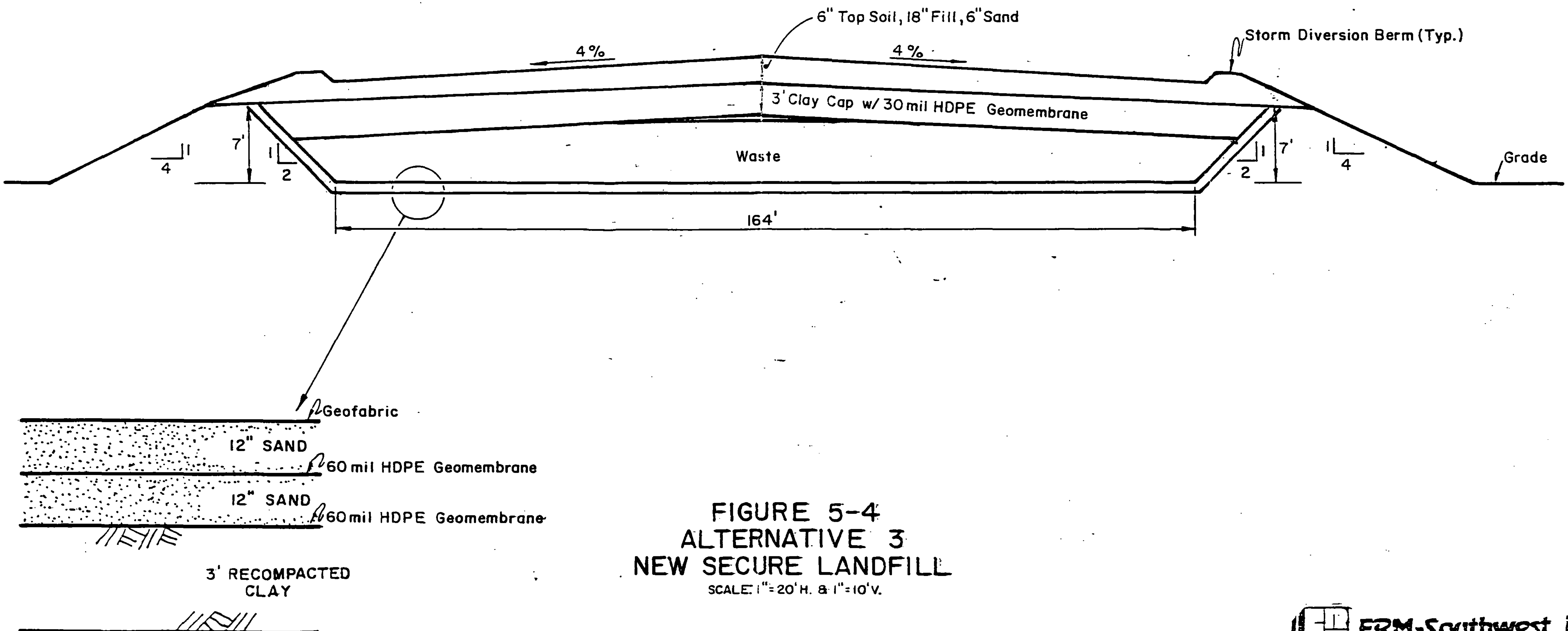

FIGURE 5-4
ALTERNATIVE 3
NEW SECURE LANDFILL
SCALE: 1" = 20' H. & 1" = 10' V.

ERM-Southwest, inc.
Houston, Texas

required. The new landfill area will be surrounded by a six foot high, chain-link, three strand barbed wire security fence. Fill required to backfill the excavated areas was assumed to be borrowed from adjacent areas.

The capital costs for Alternative 3 are listed in Table 5-5. Pumps and sump pumps required by the primary and secondary leachate collection systems and the electrical system power feed are included in this estimate. Long term (30 year) maintenance and five year ground water monitoring costs are shown in Table 5-6. Approximately 1.5 acres will be taken out of agricultural use at a cost of $1,200 per acre for a land cost of $1,800.

Total costs for this alternative are summarized as follows:

Total Capital Costs		$515,000
Total Long Term Maintenance and Monitoring		175,000
Total Land Costs		1,800
Total costs alternative 3		$691,800
	say	$692,000

* Based on the assumption that interest and inflation rates are roughly equivalent.

5.1.4 Alternative 4 - Cap All Waste In-Place

Alternative 4 includes surrounding the waste area with short dikes and capping all the waste in-place with a low permeability 5.5 foot thick cap as shown in Figure 5-5. The cap will consist of 6 inches of topsoil, 18 inches of fill, six inches of sand, a 30 mil HDPE geomembrane and three feet of recompacted clay. The slope of the cap will be 2.5 percent. The permeability of the clay will be at least 1 X 10^{-7} cm/sec or less. Based on recent testing of on-site soils, this permeability can be achieved. The clay will be notched into the dike as also shown in Figure 5-5 in order to minimize the surface area required. The adjacent sections of asphalt road will be broken up and left in-place.

The capital costs for Alternative 4, which also includes seeding and fencing, are listed in Table 5-7. The long-term (30 year) maintenance and (3 year) ground water monitoring costs are included in Table 5-8. Less than two acres will be taken out of agricultural use at an estimated cost of $2,400.

TABLE 5-5

Capital Costs - Alternative 3

Mobilization, Demobilization and Safety Equipment	=	$ 8,000
Unclassified Fill - Borrowed from adjacent areas - used for berms and fill within landfill - compacted in place 8,950 cu.yd. @ $3.70/cu.yd.	=	33,100
Excavate waste and place in landfill 4,970 cu.yd. @ $3.00/cu.yd.	=	15,000
Recompacted Clay Liners - borrowed from adjacent areas - used for top and bottom landfill liners - 1 X 10^{-7} cm/sec permeability 7,580 cu.yd. @ $4.50/cu.yd.	=	34,100
High permeability sand drainage layers for cap and bottom liners - from off-site 2,600 cu.yd. @ $10.00/cu.yd.	=	26,000
Topsoil 561 cu.yd. @ $6.00/cu.yd.	=	3,400
Seed and fertilizer 7,100 sq.yd. @ $1.00/sq.yd.	=	7,100
HDPE Geomembranes Cap - 30 Mil - 33,100 sq.ft. @ 0.45/sq.ft.	=	14,900
Bottom - 60 mil(2) - 85,100 sq.ft. @ 0.75/sq.ft.	=	63,800
Geofabric - Needle punched - Nonwoven 5,350 sq.yd. @ $1.00/sq.yd.	=	5,350

TABLE 5-5 (continued)

Leachate Collection System includes:		
Concrete manholes, 4" slotted HDPE and sump pumps(2)	=	6,000
Secondary Leachate Collection System includes:		
Pump, generator, portable tank, & 3" slotted HDPE	=	2,400
Security Fencing - 6 ft. high chainlink, 3 strand barbed wire, vehicle and pedestrian gates	=	20,700
Residual Soil Analyses, 66 @ $210 each	=	13,900
Electrical System Power Feed	=	5,000
Backfill excavated areas and grade 4,970 cu.yd. @ $4.00/cu.yd.	=	19,900
Drainage Ditches excavation 450 cu.yd. @ $4.50/cu.yd.	=	2,000
Leachate Collection Tank	=	20,000
Force Main 740 l.f. @ $14.00/l.f.	=	10,400
Subtotal		$311,000
20% Contingency		62,000
Subtotal		$373,000
15% Contractor's Overhead & Profit		56,000
Subtotal		$429,000
20% Engineering & Construction Surveillance		86,000
Total Capital Cost - Alternative 3		$515,000

TABLE 5-6

Long Term Maintenance and Monitoring Costs: Alternative 3

Visual inspection, benchmarks inspection and periodic survey		
1 technician @ 16 hrs/yr x $45/hr x 30 yrs	=	$ 21,600
Maintenance (cap, monitor wells, and storm sewer)		
2 workers @ 40 hrs/yr each x $25/hr x 30 yrs	=	60,000
1 backhoe @ 8 hrs/yr x $45/hr x 30 yrs	=	10,800
5 truckloads soil or clay x 8 cu.yd./ truckload x $5.00/cu.yd. x 30 yrs	=	6,000
Mowing		
2 days/year @ $600 a day x 30 years	=	36,000
Seed and fertilize		
1 day/year @ $600/day x 30 years	=	18,000
Ground water sampling		
1 technician @ 8 hrs/yr x $45/hr x 3 yrs	=	1,100
Ground water analysis		
4 samples/yr @ $210 ea. x 3 yrs	=	2,500
Reporting		
1 engineer @ 8 hrs/yr x $45/hr x 3 yrs	=	1,100
Off-site Leachate Disposal		
2 drums per year x $300 each x 30 years	=	18,000
Total Long Term Maintenance and Monitoring Costs		$175,100
	say	$175,000

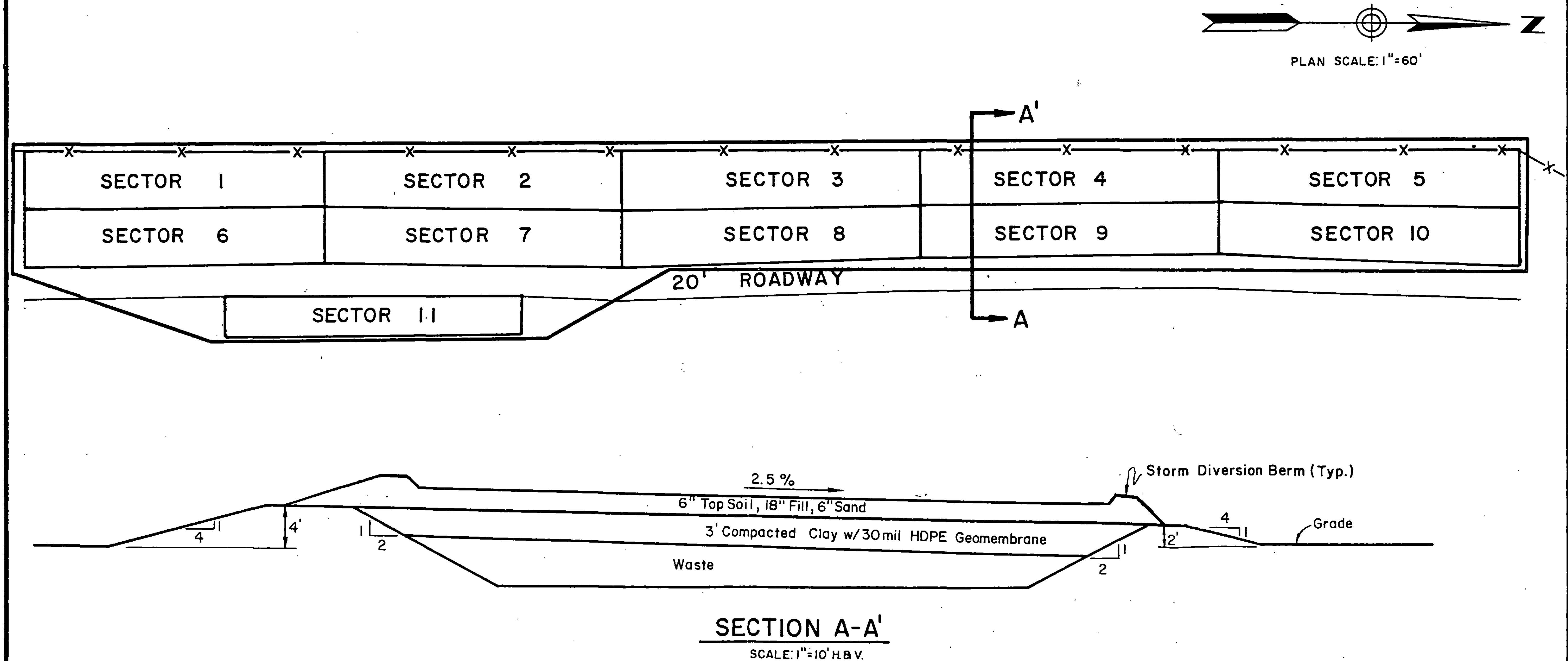

FIGURE 5-5
ALTERNATIVE 4

ERM-Southwest, inc.
Houston, Texas

TABLE 5-7

Capital Costs - Alternative 4

Mobilization, Demobilization and Safety Equipment	=	$ 8,000
Unclassified Fill 3,700 cu.yd. @ $3.70/cu.yd.	=	13,700
3' Clay Cap 7,900 cu.yd. @ $4.50/cu.yd.	=	35,600
30 Mil HDPE Geomembrane 70,800 sq.ft. @ $0.45/sq.ft.	=	31,900
6" Sand Drainage Layer 1,300 cu.yd. @ $10.00/cu.yd.	=	13,000
18" Fill 3,930 cu.yd. @ $3.70/cu.yd.	=	14,500
6" Topsoil 1,300 cu.yd. @ $6.00/cu.yd.	=	7,900
Seed and fertilizer 11,600 sq.yd. @ $1.00/sq.yd.	=	11,600
Fence - 6 foot high chainlink, 3 strand barbed wire, vehicle and pedestrian gates	=	16,600
Demolish Asphalt Road In-Place 2,000 sq.yd. @ $1.50/sq.yd.	=	3,000
Stormwater Diversion structures 4 @ $2,500 each	=	10,000
Subtotal		$166,000
20% Contingency		33,000
Subtotal		$199,000
15% Contractor's Overhead and Profit		30,000
Subtotal		$229,000
20% Engineering & Construction Surveillance		46,000
Total Capital Cost - Alternative 4		$275,000

TABLE 5-8

Long Term Maintenance and Monitoring Costs: Alternative 4

Visual inspection, benchmarks inspection and periodic survey	
1 technician @ 24 hrs/yr x $45/hr x 30 yrs	= $ 32,400
Maintenance (cap, monitor wells)	
2 workers @ 60 hrs/yr each x $25/hr x 30 yrs	= 90,000
1 backhoe @ 8 hrs/yr x $45/hr x 30 yrs	= 10,800
10 truckloads soil or clay x 8 cu.yd./ truckload x $5.00/cu.yd. x 30 yrs	= 12,000
Mowing	
2 days/year @ $600 a day x 30 years	= 36,000
Seed and fertilize	
1 day/year @ $600 a day x 30 years	= 18,000
Ground water sampling	
1 technician @ 8 hrs/yr x $45/hr x 3 years	= 1,100
Ground water analysis	
4 samples/year x 3 years @ $210 each	= 2,500
Reporting	
1 engineer @ 8 hrs/yr x $45/hr x 3 years	= 1,100
Total Long-Term Maintenance and Monitoring Costs	$203,900
	say $204,000

Total costs for Alternative 4 are summarized as follows:

Total Capital Costs	$275,000
Total Long Term Maintenance and Monitoring Costs	204,000
Total Land costs	2,400
Total Costs Alternative 4	$481,400
say	$481,000

*Based on assumption that interest and inflation are roughly equivalent.

5.1.5 Alternative 5 - Soil Cover

This alternative, which is intended to be the minimal action alternative required in the Work Plan, involves applying six inches of topsoil and six inches of fill to the entire surface of the affected soil area. This area would then be fertilized, seeded and fenced.

The capital costs for Alternative 5 are listed in Table 5-9. The long-term maintenance and monitoring costs are included in Table 5-10. Less than two acres will be taken out of agricultural use at a cost of $2,400.

Total costs for this alternative are summarized as follows:

Total Capital Costs	$ 71,000
Total Long Term Maintenance & Monitoring Costs	161,000
Total Land Costs	2,400
Total Costs Alternative 5	$ 234,400
say	$ 234,000

*Based on the assumption that interest and inflation rates are roughly equivalent.

5.1.6 Alternative 6 - In-Situ Biological Treatment Combined With Other Alternatives

Alternative 6 includes biological treatment of the pesticides remaining in the soil at levels between one and ten ppm after the higher levels of pesticides have been remediated as discussed in the preceeding alternatives. The affected surface area is illustrated in Figure 5-6.

TABLE 5-9

Capital Costs - Alternative 5

Mobilization, Demobilization and Safety Equipment	=	$ 7,500
6" Topsoil 1,310 cu.yd. @ $6.00/cu.yd.	=	7,900
6" Fill 1,310 cu.yd. @ $3.70/cu.yd.	=	4,850
Seed & fertilizer 7,860 sq.yd. @ $1.00/sq.yd.	=	7,900
Fencing - 6 foot high chainlink, 3 strand barbed wire, vehicle and pedestrian gates.	=	16,600
Subtotal		$45,000
20% Contingency		9,000
Subtotal		$54,000
15% Contractor's Overhead and Profit		8,000
Subtotal		$62,000
15% Engineering & Construction Surveillance		9,000
Total Capital Cost - Alternative 5		$71,000

TABLE 5-10

Long Term Maintenance and Monitoring Costs: Alternative 5

Visual inspection, benchmarks inspection and periodic survey 1 technician @ 16 hrs/yr. x $45/hr x 30 yrs.	=	$ 21,600
Maintenance (cap, monitor wells) 2 workers @ 40 hrs/yr each x $25/hour x 30 yrs	=	60,000
1 backhoe @ 8 hrs/yr x $45/hour x 30 yrs	=	10,800
8 truckloads soil or clay x 8 cu.yd./ truckload x $5.00/cu.yd. x 30 yrs	=	9,600
Mowing 2 days/year @ $600 a day x 30 yrs	=	36,000
Seed and fertilize 1 day/yr. @ $600/day x 30 yrs	=	18,000
Ground water sampling 1 technician @ 8 hrs/yr x $45/hr x 3 yrs	=	1,100
Ground water analysis 4 samples/yr @ $210 ea. x 3 yrs	=	2,500
Reporting 1 engineer @ 8 hrs/yr. x $45/hr x 3 yrs	=	1,100
Total Long Term Maintenance and Monitoring Costs		$160,700
	say	$161,000

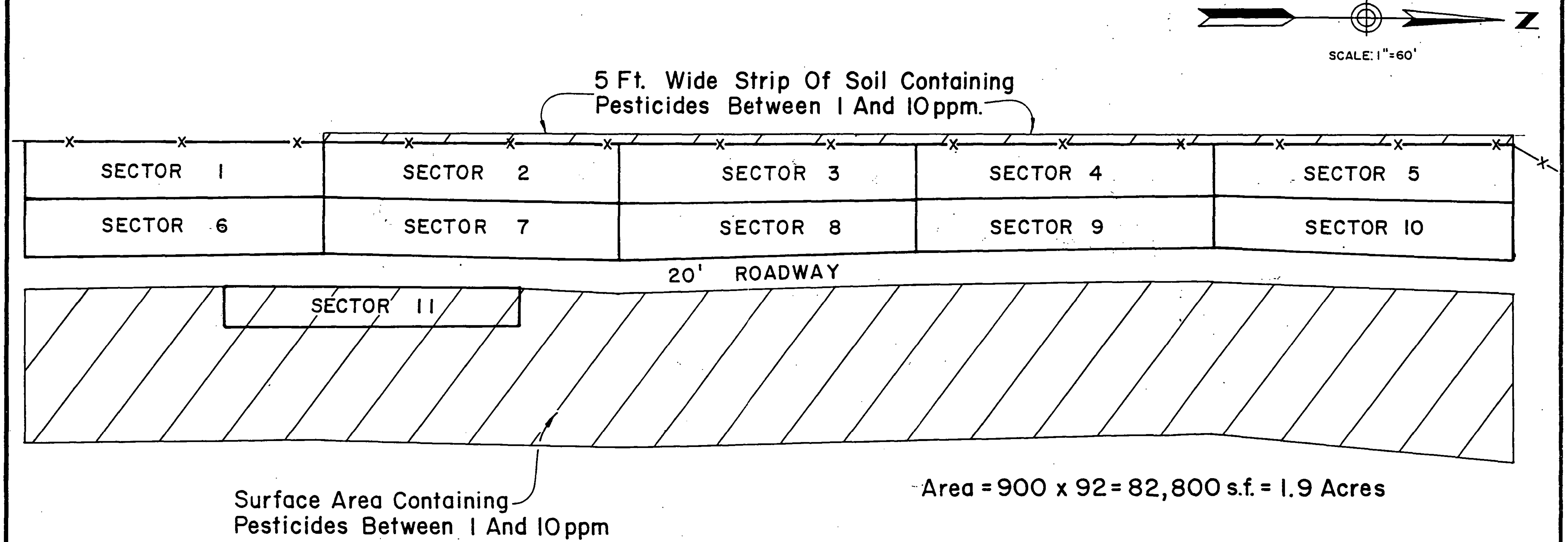

FIGURE 5-6
ALTERNATIVE 6
AFFECTED SOIL AREA

ERM-Southwest, inc.
Houston, Texas

Various laboratory experiments [1,2,3,4,5,6] have shown that over longer periods of time such as several months, naturally occurring microorganisms can dechlorinate, i.e. breakdown the pesticides found at the Area G site. The factors that affect the growth rate and subsequent dechlorination of the pesticides include:

1. concentration of the pesticides
2. concentration of the microbes
3. soil moisture content
4. ratio of carbon and nitrogen (C/N) in the soil
5. soil temperature
6. soil pH

Whether there has been any significant decrease in the concentrated pesticide residues at the site cannot be determined, since high pesticide concentrations (>1000 ppm) still remain after 30 or more years of outdoor exposure.

It was determined during the soils investigation that the background pesticide values ranged from 0.1 to 0.2 ppm. This is a significant concentration decrease from prior pesticide concentrations following application to the fields. An investigation presently underway at the University of Illinois [7], involves the field degradation of an unrelated chlorinated pesticide, 2,4-D. The data has not to date been published.

Previous investigators [8,9,10] have stated that laboratory microbial degradation of these highly chlorinated pesticides has not to date been proven under field conditions. However, if the factors affecting degradation were optimized, then the maximum biological breakdown might occur. The six factors stated previously were examined to determine those factors that could be reliably and economically controlled at the site.

Pesticide concentration, soil moisture content, C/N ratio, and soil pH can be somewhat controlled by engineering design. Microbial concentration will simply be dependent upon the growth rate of the naturally occurring microorganisms as affected by environmental factors and the remaining pesticide substrate concentration. At the present time there are no commercially available microbes capable of degrading DDT, toxaphene, and BHC which may be purchased to seed the site [11]. Therefore, the utilization of only natural organisms must be made.

The control of soil temperature at the site is simply not economical. Obviously more pesticide breakdown will occur during the warmer months of the year, when microbial activity is higher.

The cost effective analysis for this alternative was based on the following factors:

1. Discing and plowing the upper one foot soil zone to evenly distribute the pesticides and provide for minimum pesticide concentrations that may be attacked by the microbes.

2. Increasing the soil moisture content during warm dry periods by use of a sprinkler system to within 30 to 90 percent [12] of the field (water holding) capacity of the soil.

3. Analyzing the soil carbon and nitrogen content and adding any needed nitrogen by use of commercial fertilizer if C/N is greater than 35.

4. Analyzing soil pH and adjusting if necessary with lime to a range of 4 to 10. Adjusting the soil pH is not believed to be necessary.

The 1.9 acre area containing an estimated 1600 cubic yards of affected soil will be initially analyzed for pH and nutrient additives. After any chemical additions have been made, the site will be thoroughly plowed and disced to a depth of one foot. The sprinkler system and connecting piping will be installed. It is estimated that the NWIRP fire/water system at the site will have sufficient pressure and capacity to supply the sprinkler system. A simple daily timer would be used to control the system. It will be set for small irrigation applications to occur once or twice per week. This will provide sufficient soil moisture content and prevent site flooding and any subsequent ground water contamination.

A grass cover will be planted to help stabilize the soil moisture content and prevent erosion.

The capital costs to affect this treatment are listed in Table 5-11. The thirty year maintenance and monitoring costs are listed in Table 5-12. The 1.9 acre site would be included in the fenced area. Fencing costs have been included in the previous alternatives. The costs to remove the 1.9 acres from active agricultural production was estimated to roughly equal the value of the land estimated at $1,200 per acre for a total land cost of approximately $2,200.

TABLE 5-11

Capital Costs For Alternative 6
In-Situ Biological Treatment

Move 5 foot Wide Strip of Soil - 6 in. deep from West Side of Fence and Spread 70 c.y. @ $5.00/cu.yd.	$ 400
Plowing, Discing and Seeding 1.9 Acres at $1000/Acre	1,900
Carbon, Nitrogen & pH Analyses 16 @ $37/each	600
Lime and Fertilizer (Allowance)	400
Irrigation System, Connecting Piping, Timer, Electric Valve Operator and Wiring	12,000
Subtotal	$15,000
20% Contingency	3,000
Subtotal	$18,000
15% Contractors Overhead & Profit	3,000
Subtotal	$21,000
20% Engineering Costs	4,000
Total Capital Costs	$25,000

TABLE 5-12

Long Term Maintenance and Monitoring Costs: Alternative 6

Plowing, Discing and Seeding 1.9 Acres Every 10 years @ $1000/acre	$ 5,700
Carbon, Nitrogen & pH Analyses Every 10 years @ $600	1,800
Soil Pesticide Analyses Every 10 years @ $840	2,500
Lime and Fertilizer Every 10 years @ $400	1,200
Irrigation System Maintenance 10% Per Year x 30 years = $1,200 x 30 =	36,000
Water & Labor Costs $500/year x 30 years	15,000
Total Long Term Maintenance and Monitoring Costs	$62,200
say	$62,000

Total costs for this alternative are summarized as follows:

Total Capital Costs	$25,000
Total Long Term Maintenance and Monitoring Costs	62,000
Total Land Costs	2,200
Total Costs - Alternative 6	$89,200
	say $89,000

*Based on the assumption that interest and inflation are roughly equivalent.

References

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2. Harvey, J. "A Simple Method of Evaluating Soil Breakdown of C-14 Labeled Pesticides Under Field Conditions." Residue Review 1983. 85:127-137.

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7. Chakrabarty, Ananda. University of Illinois, Department of Medical Microbiology. Personal Communication. 17 May 1985. (312) 996-7470.

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11. Nassef, Tony. Polybac Corp. Personal Communication. 20 May 1985. (904) 968-9549.

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5.2 Alternatives Evaluation

Each of the six alternatives will be evaluated and compared with each other based on the following criteria:

1. technological feasibility
2. reliability
3. associated environmental and health risks
4. long-term maintenance and monitoring
5. estimated costs.

5.2.1 Technological Feasibility

Alternatives 1 through 5 (off-site commercial landfilling, consolidation and capping, on-site RCRA landfilling, capping in place and minimal action) were all found to be technically feasible. That is they can all be accomplished with proven technology that is widely available. Each of those five alternatives will isolate the waste from the environment and meet the Remedial Objective.

Alternative 6, biological treatment was not considered for affected soils with pesticide concentrations greater than 10 ppm. For soils containing pesticides between one and ten ppm in conjunction with the other alternatives, the method is unproven under actual field conditions. Therefore, Alternative 6 was found to have a low technological feasibility.

5.2.2 Reliability

Alternatives one through five (off-site commercial landfilling, consolidation and capping, on-site RCRA landfilling, capping in place and soil cover) were all found to be reliable in accomplishing the intended function. That is they will all perform adequately over a long period of time with routine maintenance.

Alternative 6 was found to be completely unreliable for pesticide concentrations above 10 ppm with poor reliability for concentrations between one and ten ppm.

5.2.3 Associated Environmental and Health Risks

Alternative 1 was found to have high environmental risks associated with highway transportation of hazardous wastes. The risk of an accident spilling the waste in the environment is much higher than the risk of waste leaving the site by the other alternatives. The risk of a highway accident involving injury or death with 253 truck loads of waste over such a long haul distance is much higher than the risks of simple human exposure by leaving the waste in place.

The human exposure risks of excavating, loading, hauling and landfilling the waste is also much higher than the other alternatives.

Alternative 2 (consolidation and capping) was found to have low environmental risks. The human exposure risks associated with consolidation of the waste was considered moderate.

The environmental risk involved with an on-site RCRA landfill was found to be the lowest of all the alternatives. The health exposure associated with the complete waste excavation work in Alternative 3 however was considered moderate to moderate plus.

Capping the waste in place (Alternative 4) was found to have a low environmental risk and the lowest human exposure risk since none of the waste will be excavated.

Alternative 5, soil cover, was found to have a moderately low environmental risk when compared with the other alternatives. A very low human exposure risk was found with no waste excavation.

Since the residual affected soil would be less than 10 ppm, Alternative 6 was found to have only slight environmental and human exposure risks.

5.2.4 Long-Term Maintenance and Monitoring

The long-term maintenance and monitoring for each of the six alternatives is summarized as follows:

Alternative	Intensity
1. Off-site disposal	Low - Only pesticides below 10 ppm will remain.
2. Consolidate and cap	Medium - Maintain partial cap.
3. On-Site landfill	Medium plus - Maintain RCRA caps & pumps, and dispose of any leachate.
4. Cap In Place	High - Maintain large cap area.
5. Soil Cover	Moderately high - Maintain grass and soil cover.
6. Biological Treatment	Moderate - Requires plowing and reseeding along with residual pesticide monitoring.

ESTIMATED COSTS

The estimated costs for each of the alternatives are summarized as follows:

Alternative	Capital Costs	Long Term Maintenance & Monitoring	Land Costs	Total Costs
1. Off-site disposal	$1,310,000	$ 5,000	-0-	$1,315,000
2. Consolidate and cap	239,000	157,000	2,400	398,000
3. On-Site landfill	515,000	175,000	1,800	692,000
4. Cap In Place	275,000	204,000	2,400	481,000
5. Soil Cover	71,000	161,000	2,400	234,000
6. Biological Treatment	25,000	62,000	2,200	89,000

Total Costs are rounded to one thousand dollars.

5.2.5 Alternatives Comparison

Based on the five evaluation criteria, five alternatives are ranked in order of preference as follows:

First Alternative 2 - Consolidate and Cap.

Technically feasible, reliable, low environmental risks, moderate human exposure risks, medium intensity for long-term maintenance and monitoring. Lowest total costs of the five reliable alternatives.

Second Alternative 4 - Cap In Place.

Technically feasible, reliable, low environmental risks, lowest human exposure risks, high intensity for long-term maintenance and monitoring. Moderate total costs of the five reliable alternatives.

Third Alternative 5 - Soil Cover.

Technically feasible, reliable, less than moderate environmental risk, low human exposure risk, low intensity maintenance and monitoring. Lowest overall costs of the five reliable alternatives.

Fourth Alternative 3 - On-Site Landfill.

Technically feasible, reliable, lowest environmental risks, medium to medium plus human exposure risks, medium plus intensity for long-term maintenance and monitoring. Moderate plus total costs of the five reliable alternatives.

<u>Fifth</u> Alternative 1 - Off-Site Disposal.

Technically feasible, reliable, high environmental risks, higher human exposure and accidental injury risks, low intensity for long term maintenance and monitoring. Highest total costs of the five reliable alternatives.

Because of its unproven reliability Alternative 6 was not ranked with the other five alternatives. This alternative will only be considered in conjunction with the first ranked alternative.

After the affected soils containing pesticides greater than 10 ppm have been remediated, only lesser affected soils will remain. Those soils containing pesticides between one and ten ppm will remain in the unexcavated portions of sectors 4,5,9,10 and 11. Those soils will be backfilled with clean soil and seeded as part of Alternative 2. However, the unremediated surface soils containing one to ten ppm pesticides east of the site as shown in Figure 5-6 will not have been remediated. In Section 4 of this report it was established that remediation of soils containing pesticides below ten ppm was not necessary to protect the environment and minimize human exposure. The total costs associated with Alternative 6 using unknown reliability to accomplish remediation that is not needed cannot be justified.

However, the simple one time plowing of the areas to the east and west of the site to lower the concentrations of pesticides along with seeding and fertilizing to promote natural biological degradation is reasonable and cost effective and should be done at an estimated capital cost of $2,000. This does not include any irrigation or long-term maintenance.

6 - CONCLUSIONS

1. The shallow ground water at the site does not contain detectable concentrations of pesticides and therefore is not affected by the site.

2. Remediation of affected surface soils to a level of 10 ppm is more than adequate to protect the environment and minimize human exposure.

3. There are an estimated total of 4125 (in place) cubic yards of soil on-site containing 10 ppm or more of pesticides.

4. Out of six alternatives for remediation that were evaluated, the highest ranking alternative is Number 2 - partial consolidation and capping.

5. Plowing, fertilizing and seeding a 2 acre area east and west of the site to promote natural biological degradation for lesser affected soils is reasonable.

7 - RECOMMENDATIONS

1. Implement Remedial Alternative 2 - partial consolidation of 1400 cubic yards of affected soil into a smaller area of the site, constructing side berms and a low permeability cap. The excavated areas will be backfilled with clean soil, seeded and fertilized to prevent ponding.

2. Continue monitoring the shallow ground water for three years for pesticides.

3. Plow, seed, and fertilize the 2 acre area of lesser affected soils east and west of the site.

4. Install a security fence around the low permeability cap area.

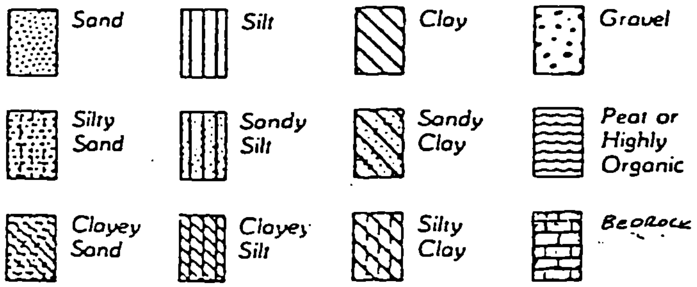
5. Maintain partial cap to prevent release of pesticides to the environment.

APPENDIX A

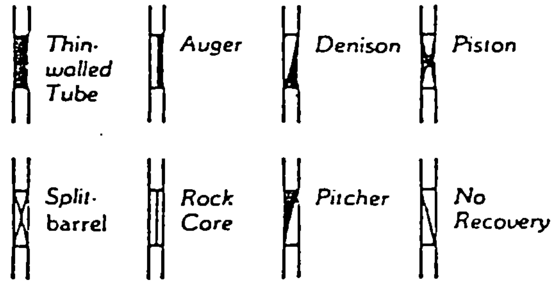
Drilling Logs

TERMS AND SYMBOLS USED ON BORING LOGS

SOIL TYPES



SAMPLER TYPES



SOIL GRAIN SIZE

U.S. STANDARD SIEVE

	6"	3"	3/4"	4	10	40	200		
BOULDERS	COBBLES	GRAVEL		SAND			SILT	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		
	152	76.2	19.1	4.76	2.00	0.420	0.074	0.002

SOIL GRAIN SIZE IN MILLIMETERS

STRENGTH OF COHESIVE SOILS (1)

Consistency	Undrained Shear Strength, Kips Per Sq Ft
Very Soft	less than 0.25
Soft	0.25 to 0.50
Firm	0.50 to 1.00
Stiff	1.00 to 2.00
Very Stiff	2.00 to 4.00
Hard	greater than 4.00

DENSITY OF GRANULAR SOILS (2,3)

Descriptive Term	*Relative Density, %
Very Loose	less than 15
Loose	15 to 35
Medium Dense	35 to 65
Dense	65 to 85
Very Dense	greater than 85

*Estimated from sampler driving record

SPLIT-BARREL SAMPLER DRIVING RECORD

Blows Per Foot	Description
25	25 blows drove sampler 12 inches, after initial 6 inches of seating.
50/7"	50 blows drove sampler 7 inches, after initial 6 inches of seating.
Ref/3"	50 blows drove sampler 3 inches during initial 6-inch seating interval.

Note : To avoid damage to sampling tools, driving is limited to 50 blows during or after seating interval.

SOIL STRUCTURE (1)

Slickensided	Having planes of weakness that appear slick and glossy. The degree of slickensidedness depends upon the spacing of slickensides and the ease of breaking along these planes.
Fissured	Containing shrinkage or relief cracks, often filled with fine sand or silt; usually more or less vertical.
Pocket	Inclusion of material of different texture that is smaller than the diameter of the sample.
Parting	Inclusion less than 1/8 inch thick extending through the sample.
Seam	Inclusion 1/8 inch to 3 inches thick extending through the sample.
Layer	Inclusion greater than 3 inches thick extending through the sample.
Laminated	Soil sample composed of alternating partings or seams of different soil type.
Interlayered	Soil sample composed of alternating layers of different soil type.
Intermixed	Soil sample composed of pockets of different soil type and layered or laminated structure is not evident.
Calcareous	Having appreciable quantities of carbonate.

REFERENCES :

(1) ASTM D 2488

(2) ASCE Manual 56 (1976)

(3) ASTM D [illegible]

Information on each boring log is a compilation of subsurface conditions and soil or rock classifications obtained from the field as well as from laboratory testing of samples. Strata have been interpreted by commonly accepted procedures. The stratum lines on the logs may be transitional and approximate in nature. Water level measurements refer only to those observed at the times and places indicated and may vary with time, geologic condition or construction activity.

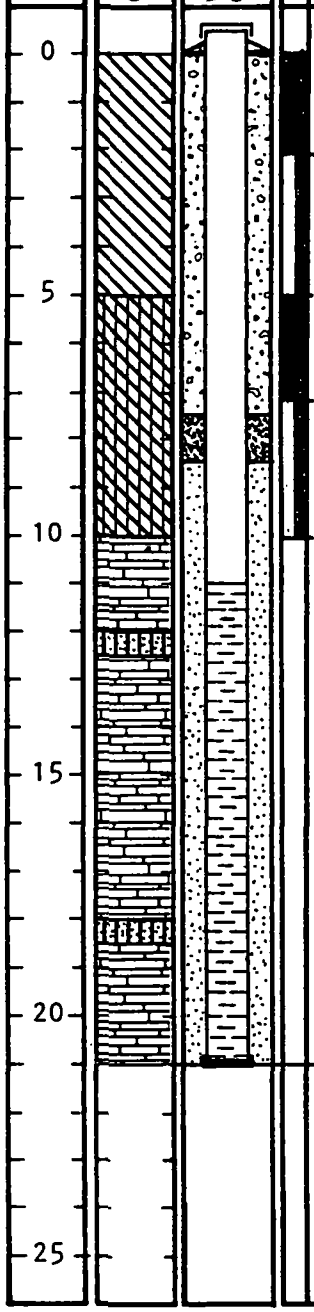
Environmental Resources Management **Drilling Log**

- Project: McGregor
- Owner: N.W.I.R.P.
- Location: Area G
- W.O. Number: 08-51
- Well Number: MW-1 (D)
- Total Depth: 21'
- Diameter: 6"
- Surface Elevation: N/A
- Water Level: Initial: 0
- 24-hrs.: 0
- Screen: Dia. 2"
- Length: 10'
- Slot Size: .010"
- Casing: Dia. 2"
- Length: 12'
- Type: SCH 40 PVC
- Drilling Company: McClelland
- Drilling Method: Auger/Rotary Wash at 10'
- Driller: W. Lungsford
- Log By: G. Swinford
- Date Drilled: 8/16/84

Sketch Map

Notes

Depth (Feet) | Graphic Log | Well Construction | Samples | Penetrometer Tons/Sq.Ft.



Description Interval	Description/Soil Classification (Color, Texture, Structures)
0.0-5.0	Very dark brown to black clay with a trace of silt, dry, very stiff
5.0-10.0	Light tan calcareous silty clay, common zones of calcium carbonate (20%, up to 40mm in diameter), dry, loose (Caliche)
10.0-12.0	Light gray and tan fine to medium crystalline sparite (Limestone)
12.0-12.5	Tan and gray sandy silt (sand is fine), common iron staining (20%), dry, firm
12.5-18.0	Same as 10.0' to 12.0'
18.0-18.5	Driller reports soft zone (possibly the same as 12.0' to 12.5')
18.5-21.0	Same as 10.0' to 12.0'
	See comments on Page 2 of 2

Environmental Resources Management

Drilling Log

Project ______ Owner ______

Location ______ W.O. Number ______

Well Number MW-1 (D) Total Depth ______ Diameter ______

Surface Elevation ______ Water Level: Initial ______ 24-hrs. ______

Screen: Dia. ______ Length ______ Slot Size ______

Casing: Dia. ______ Length ______ Type ______

Drilling Company ______ Drilling Method ______

Driller ______ Log By ______ Date Drilled ______

Sketch Map

Notes

Depth (Feet)	Graphic Log	Well Construction	Samples	Penetrometer Tons/Sq.Ft.	Description Interval	Description/Soil Classification (Color, Texture, Structures)

PROTECTIVE CASING CONSTRUCTION:

1. After samples were collected, a 6" diameter protective casing was installed, to a depth of 10', to insure that no pesticides contaminated the newly encountered sediment. This was done by:
   (1) Augering an 8" diameter hole down to 10'
   (2) Installing a 10' section of 6" diameter SCH 40 PVC pipe and forcing that pipe into the floor of the hole, and
   (3) Grouting the annulus between the hole and the outside of the PVC pipe.
2. Wells were installed 24 hours later by drilling through the center of the 6" diameter PVC protective casing.

WELL CONSTRUCTION:

1. SCH 40 PVC threaded pipe and thread-on caps were used for well construction.
2. 10', .010" SCH 40 PVC Screen (11.0' to 21.0').
3. 12', SCH 40 PVC Riser which stubs-out 1.0' above the ground surface.
4. Cement/Bentonite mix 0 to 7.5'.
5. Bentonite seal 7.5' to 8.5'.
6. Sand pack 8.5' to 21.0'.
7. A portland cement concrete base was installed around the well at the ground surface.
8. An outer casing was installed with a locking cap.

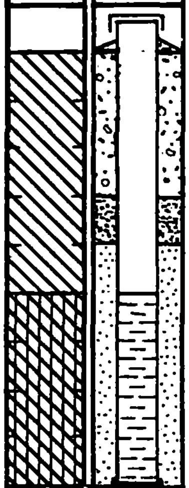
Environmental Resources Management

Drilling Log

Project: McGregor
Owner: N.W.I.R.P.
Location: Area G
W.O. Number: 08-51
Well Number: MW-1 (S)
Total Depth: 9'
Diameter: 6"
Surface Elevation: N/A
Water Level: Initial: 0
24-hrs.: 0
Screen: Dia.: 2"
Length: 4'
Slot Size: .010"
Casing: Dia.: 2"
Length: 6'
Type: SCH 40 PVC
Drilling Company: McClelland
Drilling Method: Auger
Driller: W. Lungsford
Log By: G. Swinford
Date Drilled: 8/17/84

Sketch Map

Notes

Depth (Feet)	Graphic Log	Well Construction	Samples	Penetrometer Tons/Sq.Ft.	Description Interval	Description/Soil Classification (Color, Texture, Structures)
0						SEE DESCRIPTION MW-1 (D)
5						
10						

WELL CONSTRUCTION:

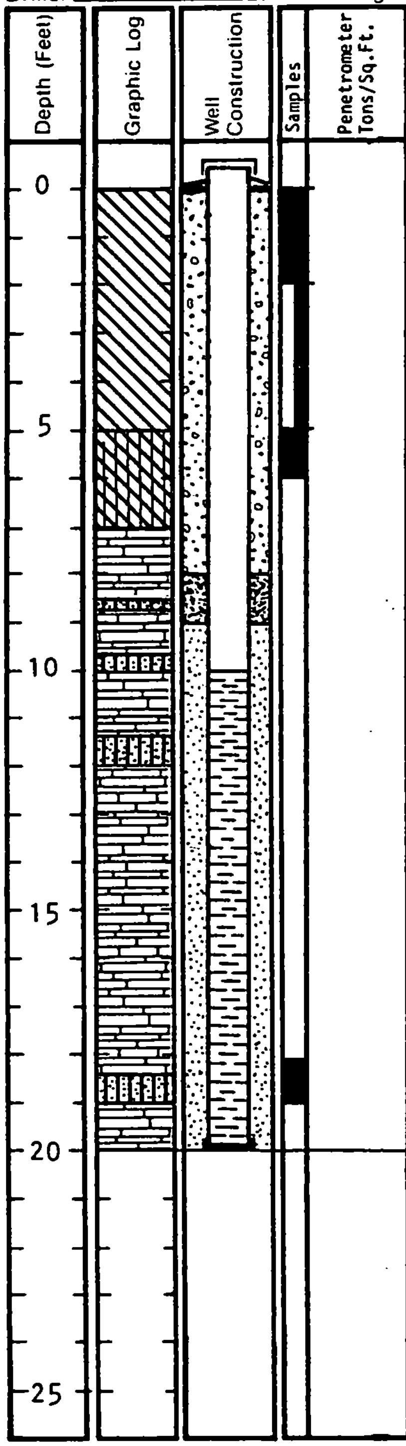
1. SCH 40 PVC threaded pipe and thread-on caps were used for well construction.
2. 4', .010" SCH 40 PVC screen (5.0' to 9.0')
3. 6', SCH 40 PVC Riser which stubs-out 1.0' above the ground surface.
4. Cement/Bentonite mix 0-3.0'.
5. Bentonite Seal 3.0' to 4.0'.
6. Sand pack 4.0' to 9.0'.
7. A portland cement concrete base was installed around the well at the ground surface.
8. An outer casing was installed with a locking cap.

Environmental Resources Management

Drilling Log

Project: McGregor
Owner: N.W.I.R.P.
Location: Area G
W.O. Number: 08-51
Well Number: MW-2 (D)
Total Depth: 20'
Diameter: 6"
Surface Elevation: N/A
Water Level: Initial: 0
24-hrs.: 0
Screen: Dia. 2"
Length: 10'
Slot Size: .010"
Casing: Dia. 2"
Length: 11.0'
Type: SCH 40 PVC
Drilling Company: McClelland
Drilling Method: Auger/Rotary Wash at 6'
Driller: W. Lungsford
Log By: G. Swinford
Date Drilled: 8/17/84

Sketch Map



Description Interval	Description/Soil Classification (Color, Texture, Structures)
0.0-5.0	Very dark brown to black clay, slightly moist, very stiff
5.0-7.0	Light tan, beige and white silty clay, with a trace of fine sand, common calcium carbonate zones (20%, up to 20mm in diameter), dry, loose (Caliche)
7.0-8.6	Light gray and tan fine to medium crystalline sparite (Limestone)
8.6-8.8	Driller reports soft zone, probably sandy silt
8.8-9.8	Same as 7.0' to 8.6'
9.8-10.0	Driller reports soft zone, probably sandy silt
10.0-11.5	Same as 7.0' to 8.6'
11.5-12.0	Driller reports soft zone, probably sandy silt
12.0-18.5	Same as 7.0' to 8.6'
18.5-19.0	Tan and gray sandy silt (sand is fine) common iron staining (15%), dry, loose
19.0-20.0	Same as 7.0' to 8.6'

See comments on Page 2 of 2

Environmental Resources Management

Drilling Log

Project ______ Owner ______

Location ______ W.O. Number ______

Well Number MW-2 (D) Total Depth ______ Diameter ______

Surface Elevation ______ Water Level: Initial ______ 24-hrs. ______

Screen: Dia. ______ Length ______ Slot Size ______

Casing: Dia. ______ Length ______ Type ______

Drilling Company ______ Drilling Method ______

Driller ______ Log By ______ Date Drilled ______

Sketch Map

Notes

Depth (Feet)	Graphic Log	Well Construction	Samples	Penetrometer Tons/Sq.Ft.	Description Interval	Description/Soil Classification (Color, Texture, Structures)
						PROTECTIVE CASING CONSTRUCTION 1. After samples were collected, a 6" diameter protective casing was installed, to a depth of 7', to insure that no pesticides contaminated the newly encountered sediment. This was done by: (1) Augering an 8" diameter hole down to 7'. (2) Installing a 7' section of 6" diameter SCH 40 PVC pipe and forcing that pipe into the floor of the hole, and (3) Grouting the annulus between the hole and the outside of the PVC pipe. 2. Wells were installed 24 hours later by drilling through the center of the 6" diameter PVC protective casing. WELL CONSTRUCTION 1. SCH 40 PVC threaded pipe and thread-on caps were used for well construction. 2. 10', .010" SCH 40 PVC screen (10.0'-20.0') 3. 11', SCH 40 PVC Riser which stubs-out 1.0' above the ground surface. 4. Cement/Bentonite mix 0 to 8.0'. 5. Bentonite seal 8.0' to 9.0'. 6. Sand pack 9.0' to 20.0' 7. A portland cement concrete base was installed around the well at the ground surface. 8. An outer casing was installed with a locking cap.

Environmental Resources Management

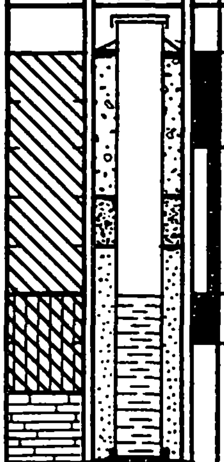
Drilling Log

Project: McGregor
Owner: N.W.I.R.P.
Location: Area G
W.O. Number: 08-51
Well Number: MW-2 (S)
Total Depth: 8.5'
Diameter: 6"
Surface Elevation: N/A
Water Level: Initial: 0
24-hrs.: 0
Screen: Dia.: 2"
Length: 3.5'
Slot Size: .010"
Casing: Dia.: 2"
Length: 6.0'
Type: SCH 40 PVC
Drilling Company: McClelland
Drilling Method: Auger
Driller: W. Lungsford
Log By: G. Swinford
Date Drilled: 8/18/84

Sketch Map

Notes

Depth (Feet)	Graphic Log	Well Construction	Samples	Penetrometer Tons/Sq.Ft.	Description Interval	Description/Soil Classification (Color, Texture, Structures)
0, 5, 10						SEE DESCRIPTION MW-2 (D)



SEE DESCRIPTION MW-2 (D)

WELL CONSTRUCTION:

1. SCH 40 PVC threaded pipe and thread-on caps were used for well construction.
2. 3.5',.010" SCH 40 PVC screen (5.0' to 8.5').
3. 6', SCH 40 PVC riser which stubs-out 1' above ground surface.
4. Cement/Bentonite mix 0 to 3.0'.
5. Bentonite seal 3.0' to 4.0'.
6. Sand pack 4.0' to 8.5'.
7. A portland cement concrete base was installed around the well at the ground surface.
8. An outer casing was intalled with a locking cap.

Environmental Resources Management

Drilling Log

Project: McGregor Owner: N.W.I.R.P.

Location: Area G W.O. Number: 08-51

Well Number: MW-3 (D) Total Depth: 10' Diameter: 6"

Surface Elevation: N/A Water Level: Initial: 0 24-hrs.: 0

Screen: Dia. 2" Length: 4' Slot Size: .010"

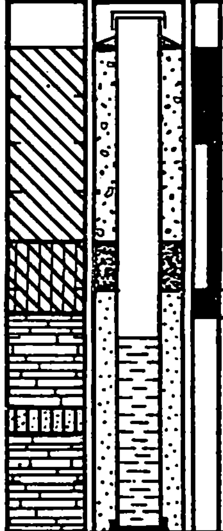
Casing: Dia. 2" Length: 7' Type: SCH 40 PVC

Drilling Company: McClelland Drilling Method: Auger/Rotary Wash at 5'

Driller: W. Lungsford Log By: G. Swinford Date Drilled: 8/16/84

Sketch Map

Notes



Depth (Feet)	Description Interval	Description/Soil Classification (Color, Texture, Structures)
0	0.0-4.0	Very dark brown to black clay with a trace of silt, infrequent calcium carbonate pebbles (<1%, up to 4mm in diameter), dry, firm
	4.0-5.5	Light tan to beige silty clay with common calcium carbonate pebbles (40%, up to 10mm in diameter) dry, loose (Caliche)
5	5.5-7.5	Light gray fine to medium crystalline sparite (Limestone)
	7.5-8.0	Driller reports soft material present
	8.0-10.0	Same as 5.5' to 7.5'
10		
15		
20		
25		

Column headings: Depth (Feet), Graphic Log, Well Construction, Samples, Penetrometer Tons/Sq.Ft., Description Interval, Description/Soil Classification (Color, Texture, Structures)

See comments on Page 2 of 2

Environmental Resources Management **Drilling Log**

Project ____ Owner ____

Location ____ W.O. Number ____

Well Number MW-3 (D) Total Depth ____ Diameter ____

Surface Elevation ____ Water Level: Initial ____ 24-hrs. ____

Screen: Dia. ____ Length ____ Slot Size ____

Casing: Dia. ____ Length ____ Type ____

Drilling Company ____ Drilling Method ____

Driller ____ Log By ____ Date Drilled ____

Sketch Map

Notes

Depth (Feet)	Graphic Log	Well Construction	Samples	Penetrometer Tons/Sq.Ft.	Description Interval	Description/Soil Classification (Color, Texture, Structures)
						PROTECTIVE CASING CONSTRUCTION: 1. After samples were collected, a 6" diameter protective casing was installed, to a depth of 5.5', to insure that no pesticides contaminated the newly encountered sediment. This was done by: (1) Augering an 8" diameter hole down to 5.5', (2) Installing a 5.5' section of 6" diameter SCH 40 PVC pipe and forcing that pipe into the floor of the hole, and (3) Grouting the annulus between the hole and the outside of the PVC pipe. 2. Wells were installed 24 hours later by drilling through the center of the 6" diameter PVC protective casing. WELL CONSTRUCTION: 1. SCH 40 PVC threaded pipe and thread-on caps were used for well construction. 2. 4', .010" SCH 40 PVC screen (6.0' to 10.0'). 3. 7', SCH 40 PVC riser which stubs-out 1' above the ground surface. 4. Cement/Bentonite mix 0 to 4.0'. 5. Bentonite seal 4.0' to 5.0'. 6. Sand pack 5.0' to 10.0'. 7. A portland cement concrete base was installed around the well at the ground surface. 8. An outer casing was installed with a locking cap.

Environmental Resources Management

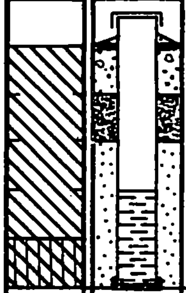
Drilling Log

Project	McGregor	Owner	N.W.I.R.P.		
Location	Area G	W.O. Number	08-51		
Well Number	MW-3 (S)	Total Depth	5'	Diameter	6"
Surface Elevation	N/A	Water Level: Initial	0	24-hrs.	0
Screen: Dia.	2"	Length	2'	Slot Size	.010'
Casing: Dia.	2"	Length	4'	Type	SCH 40 PVC
Drilling Company	McClelland	Drilling Method	Auger		
Driller	W. Lungsford	Log By	G. Swinford	Date Drilled	8/18/84

Sketch Map

Notes

Depth (Feet)	Graphic Log	Well Construction	Samples	Penetrometer Tons/Sq.Ft.	Description Interval	Description/Soil Classification (Color, Texture, Structures)
0						SEE DESCRIPTION MW-3 (D)
5						



WELL CONSTRUCTION:

1. SCH 40 PVC threaded pipe and thread-on caps were used for well construction.
2. 2', .010" SCH 40 PVC screen 3.0' to 5.0'.
3. 4', SCH 40 PVC riser which stubs-out 1' above the ground surface.
4. Cement/Bentonite mix 0 to 1.0'.
5. Bentonite seal 1.0' to 2.0'.
6. Sand pack 2.0' to 5.0'.
7. A portland cement concrete base was installed around the well at the ground surface.
8. An outer casing was installed with a locking cap.

APPENDIX B

Physical Properties of On-Site Soils

Professional Service Industries, Inc.
National Soil Services Division

March 18, 1985
Report No. 286-55028

ERM Southwest, Inc.
8989 Westheimer, Suite 111
Houston, Texas 77063

Attention: Mr. Guy Swinford

LABORATORY TEST RESULTS
PERMEABILITY TEST ON COMPACTED SAMPLES

Gentlemen:

We are pleased to submit the laboratory test results conducted on the sample provided by ERM. The testing was authorized by Mr. G. Swinford on February 28, 1985.

The soil provided has the following physical properties:

Atterberg Limits:	Liquid Limit = 58
	Plastic Limit= 29
	Plasticity Index = 29
	% Passing #200 Sieve = 92
Classification:	Dark Brown Clay (CH)

In addition to physical classification, the soil optimum moisture density relationship was determined and is reported by the accompanying Plate. It was also requested that the permeability of the soil be determined for a condition defined by a compacted dry density greater than 95% and less than 100% of Standard Proctor; and with moisture contents ranging from 0 to +4% of optimum moisture content. The results of the permeability test is as follows:

Coefficient of permeability = 2.8×10^{-9} cm/sec

If you have any questions, please call.

Very truly yours,

NATIONAL SOIL SERVICES DIVISION

R H Pitts

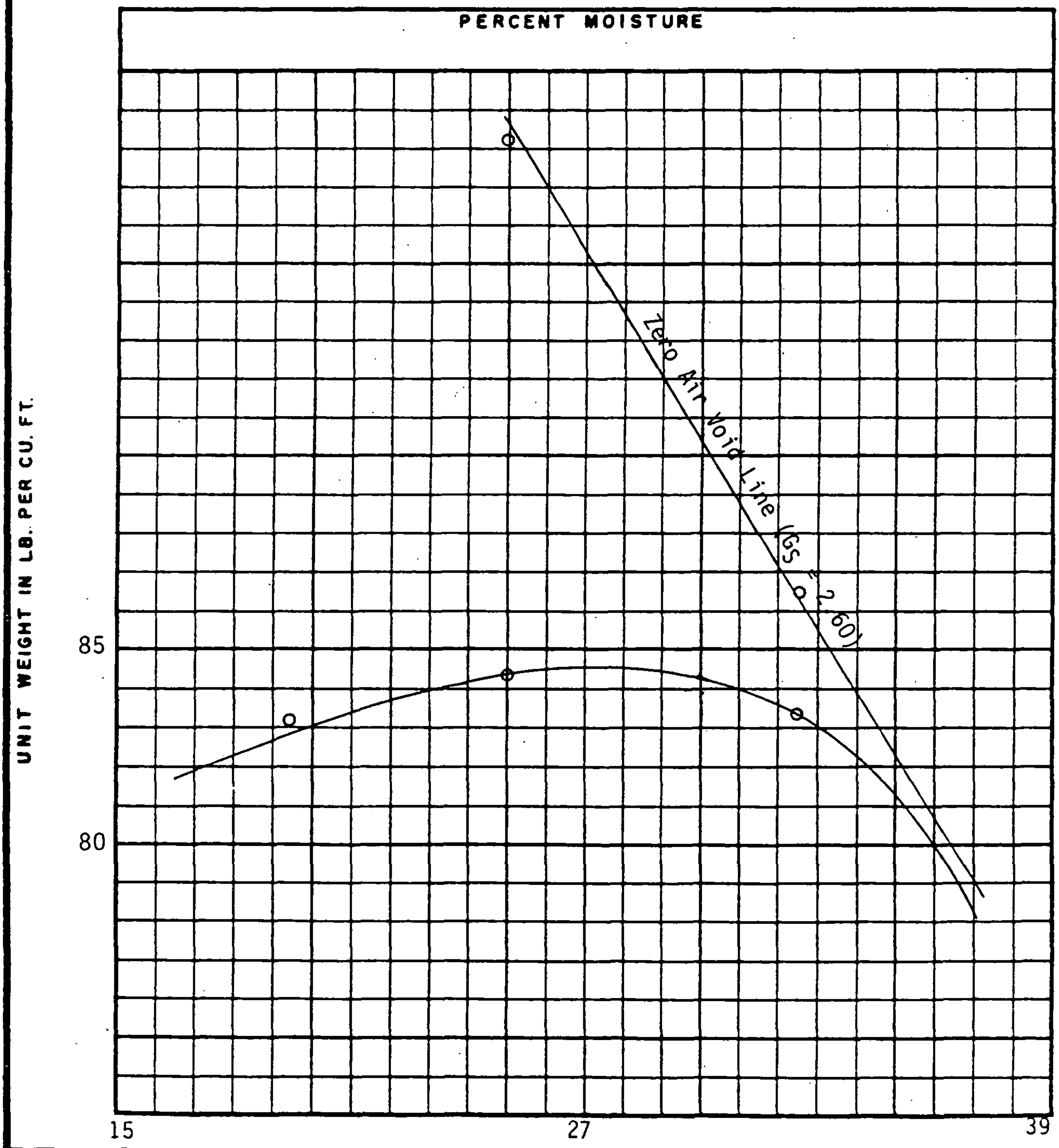
Ron H. Pitts, P.E.,
Project Engineer

RHP:ig
Copies submitted: 3

OPTIMUM MOISTURE TEST

JOB: 55028
Test Method: D 698-78
Mold: 4.0" (101.6 mm), 944 cm^3
Hammer: 5.5 lb.
Drop: 12 inches
Blows: 25
Layers:

SAMPLE: ERM
Description: Dark brown clay w/organics
Liquid Limit:
Plasticity Index:
Optimum Moisture: 27 %
Max. Unit Dry Wt. 84.5 Lb./ft.



NATIONAL SOIL SERVICES
CONSULTING ENGINEERS

PLATE